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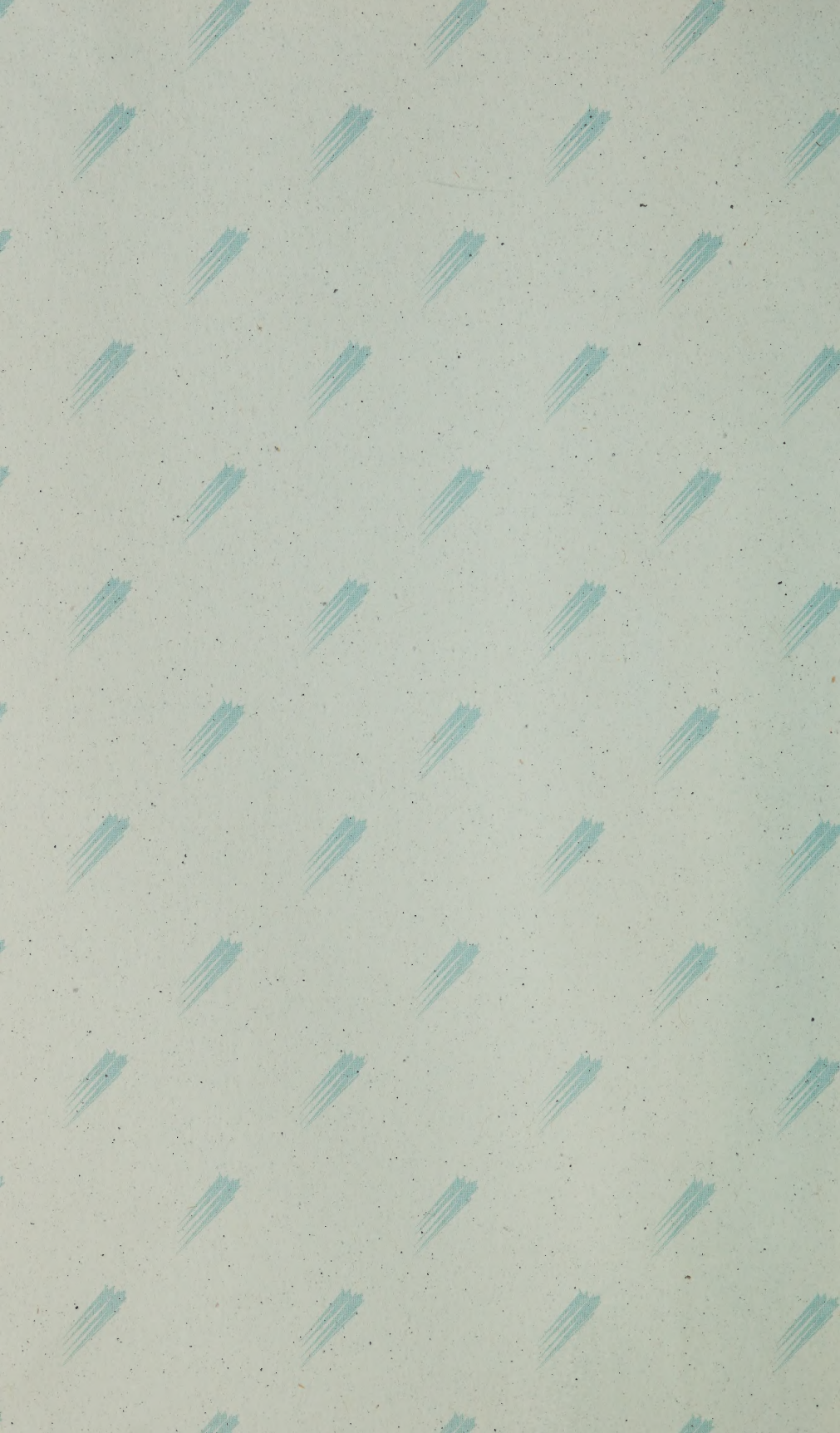
THE FINAL

REPORT OF

THE ROYAL

COMMISSION

ON NATIONAL

PASSENGER

TRANSPORTATION

Volume 2

DIRECTIONS

THE FINAL

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THE ROYAL

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ON NATIONAL

PASSENGER

TRANSPORTATION

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Introduction to Volume 2, and Relation of Volume 2 to the Royal Commission's Research Program

Volume 2 is organized as a set of Notes to Chapters 1, 2, 3, 6, 7, 8, 9 and 18 of Volume 1. The primary purpose of these notes is to explain more fully, and to document, the estimates of the amounts and costs of intercity passenger travel that were developed for this report and are used in Volume 1. Such estimates figure prominently in the analysis of current and potential future passenger transportation costs in Chapters 3 and 18 of Volume 1, in the discussion of environmental impacts of transportation in Chapter 7, and in the discussion of the accident records of the different modes of transportation and of accident costs in Chapter 8. Estimates developed by Royal Commission staff are also used in the reference to total resources devoted to transportation in Chapter 1, and, in Chapter 2, to the amounts of intercity travel by various modes, currently and historically in Canada and in other countries.

In addition, Volume 2 provides supporting material for the section on rail infrastructure in Volume 1, Chapter 6, and for the discussion of legislation, regulations and other developments relevant to the provision of transportation for people with disabilities in Volume 1, Chapter 9.

Many of the estimates developed for this report and used in Volume 1 are inevitably quite rough, and in some cases are based on particular assumptions where alternative assumptions would also have been defensible. The relevant sections of Volume 2 do not quantify the margins of uncertainty to which the various estimates are subject. It is hoped, however, that the presentation and discussion of the approaches used in developing the estimates will allow the reader to form a general impression of the margin of uncertainty, and of the sensitivity of the estimates to key assumptions.

In some cases the notes to a chapter are presented as an integrated discussion of the development of the quantitative estimates in that chapter. In other cases, the notes deal with a series of relatively independent points in the chapter. A detailed table of contents precedes each of the sets of chapter notes.

A substantial part of the contracted research, and of the staff research work, carried out for the Royal Commission contributed to the development of the estimates, particularly the comprehensive cost estimates for the different modes of intercity transportation. Volumes 3 and 4 contain 22 of the research papers prepared for the Royal Commission that were judged to be particularly relevant to the issues discussed in Volume 1 and/or to be of interest to a significant number of readers in the transportation field. In some cases, sections of Volume 2 build on material from papers in Volumes 3 and 4. Some research papers in Volumes 3 and 4 provide a self-contained development of certain estimates and analyses referred to in Volume 1, particularly in Chapters 11, 12 and 13. No further supporting material is provided for these chapters in Volume 2. Several of the papers in Volumes 3 and 4 are summaries of historical, analytical or empirical work that provide a general discussion of issues of interest to the Royal Commission, and are relevant to one or more chapters in Volume 1.

These papers are listed below in the order in which they appear in Volumes 3 and 4.

VOLUME 3

Historical Overview

D. R. Owram	Icons and Albatrosses: Passenger Transportation as Policy and Symbol in Canada
George W. Wilson	U.S. Intercity Passenger Transportation Policy, 1930–1991: An Interpretive Essay

General Surveys

Objectives

Robin Boadway   The Role of Equity Considerations in the Provision and Pricing of Passenger Transportation Services

David W. Slater   Transportation and Economic Development: A Survey of the Literature

Subsidies/Pricing/Competition

Trevor D. Heaver   Subsidies in Canadian Passenger Transportation

David Gillen and Tae Hoon Oum   Transportation Infrastructure Policy: Pricing, Investment and Cost Recovery

John Blakney   Competition Policy and Canadian Passenger Transportation

Keith Acheson and Don McFetridge   Controlling Market Power in Weakly Contestable Canadian Airline Markets

Federal-Provincial Institutional Issues

Patrick J. Monahan   Constitutional Jurisdiction over Transportation: Recent Developments and Proposals for Change

Patrick J. Monahan   Transportation Obligations and the Canadian Constitution

VOLUME 4

Applied Analyses

Costing

Ashish Lall — Transportation Infrastructure Costs in Canada

Fred P. Nix,
Michel Boucher and
Bruce Hutchinson — Road Costs

VHB Research &
Consulting Inc. — Environmental Damage from Transportation

Industry Studies

Steven A. Morrison — Deregulation and Competition in the
Canadian Airline Industry

Ron Hirshhorn — The Effects of U.S. Airline Deregulation:
A Review of the Literature

Richard Lake,
L. Ross Jacobs and
S. T. Byerley — An Analysis of the Canadian Intercity
Scheduled Bus Industry

Charles Schwier and
Richard Lake — VIA Rail Services: Economic Analysis

A. Cubukgil,
S. Borins and
M. Hoen — Airport Investment and Pricing Policies

Other

Eric J. Miller and Kai-Sheng Fan	Travel Demand Behaviour: Survey of Intercity Mode-Split Models in Canada and Elsewhere
Richard Laferrière	Price Elasticities of Intercity Passenger Travel Demand
Ken McKenzie, Jack Mintz and Kim Scharf	Differential Taxation of Canadian and U.S. Passenger Transportation
Richard Lake	Notes on Intercity Passenger Transportation Technology

Several other research papers prepared for the Royal Commission, judged to contain material potentially of use to a more limited number of readers with specialized transportation interests, are being made available in an unpublished research report series that will be distributed to libraries specializing in transportation and to large university and public libraries. These reports are:

	Author	Title
RR-01	Hickling Corporation	Transportation for People with Disabilities: A Policy Review and Analysis
RR-02	Peat Marwick Stevenson & Kellogg	Intercity Passenger Bus Regulation in Canada
RR-03	Michael K. Berkowitz	The Potential for Competition in Rail Carriage
RR-04	Sypher : Mueller International Inc.	Air Infrastructure Costing

A number of additional reports were prepared by contractors and Research Division staff. These are included in the Royal Commission material transferred to the National Archives. Several of these papers were prepared relatively early in the Royal Commission's work program and were used as inputs in subsequent work.

NOTES TO CHAPTER 1:
RESOURCES DEVOTED TO TRANSPORTATION

INTRODUCTION

Chapter 1 of Volume 1 states that in 1989 Canadians devoted resources equal to about 16% of the gross domestic product (GDP) to transportation, of which about 5% to 7% of GDP — depending on how broadly intercity travel is defined — was for intercity travel. These Notes to Chapter 1 introduce the concept of resources devoted to transportation, and sketch the way in which the estimates were derived.

The concept — total resources devoted to the transportation function or activity — is a very broad, and somewhat unconventional, measure of the size of transportation in the economy. It is used by the United States Department of Transportation (*National Transportation Statistics,* 1990, figure 1, p. 4) and the Eno Foundation (*Transportation in America*, 8th edition, May 1990, pp. 5-6) in discussions of transportation in the United States economy. A very similar concept was recently used in an article by Pierre Zalatan and Jean-Pierre Roy of Transport Canada ("The Importance of Transportation in the Canadian Economy," *Evolution in Transportation; Proceedings of the 26th Annual Meeting of the Canadian Transportation Research Forum*, Quebec City, May 1991, pp. 422-435).

The concept is somewhat unconventional because it includes resources devoted to production both of transportation services that are components of final demand, and transportation services (especially freight) that are intermediate inputs used in the production of other goods and services. Although the concept of total resources devoted to the function of transportation is of interest in arraying information on transportation resource use, it is important to recognize the consequences of including both final and intermediate activity.

If parallel estimates were made of the total resources devoted to a range of other major functions or activities in the economy — for example, to manufacturing, distribution, health care, education, public administration and so on — as well as to transportation, the total resources devoted to all these functions could well exceed the conventional measure of the total use of resources in the economy —

the GDP. This is because transportation, as well as being a final product, is an input in most of the other functions including manufacturing, education and health care. Similarly, goods or services produced by several of the other functions are used in carrying out the transportation function. The notion of total resources devoted to an economic function or activity departs from standard national income and expenditure accounts concepts, which generally focus either on final uses (rather than final plus intermediate uses) of goods and services, or on value added by (rather than total resources devoted to) economic activities or "industries." The National Accounts thus avoid counting use of resources more than once when displaying data on the full range of economic activities.

1. THE ESTIMATES

The special nature of the estimates of total resources devoted to transportation having been acknowledged, their derivation will be sketched. The objective is to obtain rough estimates of resources devoted to transportation; thus approximate procedures are used at a number of stages. In addition, to the extent possible, the estimates in this section use published data directly. In this they differ from some of the cost estimates in Chapter 3 of Volume 1 where attempts are made to quantify concepts that are judged to be important when comparing comprehensive costs of the different modes of transportation, but for which standard published data are not currently available.

Because individuals, businesses and governments are all involved both in purchasing transportation services and in directly using resources for transportation purposes, it is necessary to assemble data and estimates from a variety of sources to obtain an estimate of total resources devoted to transportation. Table 1(2)-1 shows four broad components of use of resources for transportation purposes:

I. Transportation services produced by business for sale (carrier revenues);

II. Transportation services produced by businesses for their own account — excluding business use of cars;

III. Own account car expenditures; and

IV. Government capital and operating expenditures to support transportation.

Table 1(2)-1
RESOURCES DEVOTED TO TRANSPORTATION, 1980–1989
($ BILLIONS, CURRENT DOLLARS)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
I. Transportation services produced by businesses for sale (carrier revenues including government payments to carriers)										
1. Air	4.0	4.6	4.7	4.7	5.1	5.6	6.0	6.4	7.1	7.9
2. Rail	5.3	6.1	6.3	7.0	7.6	7.7	7.6	7.9	8.0	7.4
3. Marine	1.8	2.1	1.9	2.0	1.9	1.8	1.9	1.8	1.9	2.0
4. Trucking	5.6	6.0	5.9	6.1	7.1	8.2	8.6	9.3	9.6	10.2
5. Intercity bus/ urban transit	1.8	2.1	2.4	2.6	2.7	3.0	3.4	3.7	3.8	4.3
6. Taxicabs	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8
7. Pipelines	0.7	0.8	1.1	1.3	1.4	1.5	1.6	1.9	1.9	1.8
8. Total	**19.6**	**22.3**	**22.8**	**24.2**	**26.4**	**28.5**	**29.8**	**31.7**	**33.1**	**34.5**
II. Transportation services produced on an own account basis — excluding car										
Private trucking 9. Based on published data	3.8	3.9	4.0	4.4	4.1	4.2	4.1	4.3	4.6	4.8
10. Adjustment for incomplete coverage	3.1	3.6	3.7	4.1	4.4	4.8	5.1	5.5	6.1	6.5
11. Private marine	0.3	0.4	0.3	0.4	0.6	0.5	0.3	0.4	0.4	0.3
12. Pipelines — own account	0.8	1.2	1.3	1.2	1.3	1.4	1.3	1.3	1.1	1.1
13. Allowance for private air	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6
14. Total	**8.4**	**9.4**	**9.8**	**10.5**	**10.8**	**11.4**	**11.3**	**12.1**	**12.8**	**13.3**

Table 1(2)-1 (cont'd)
RESOURCES DEVOTED TO TRANSPORTATION, 1980-1989
($ BILLIONS, CURRENT DOLLARS)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
III. Car — own account										
A. Expenditures on new and used (net) cars										
15. Personal	8.4	9.0	7.8	9.8	12.1	15.2	16.6	17.9	19.9	20.4
16. Residual (business and government)	3.0	3.2	2.4	3.3	4.5	5.6	6.3	7.5	7.9	7.7
17. Subtotal	11.4	12.2	10.2	13.2	16.6	20.8	22.9	25.5	27.8	28.2
B. Expenditures on gasoline										
18. Personal	5.9	7.8	8.6	9.0	9.6	10.4	9.5	10.2	10.6	11.5
19. Residual (business and government)	3.0	4.1	4.2	4.2	4.2	4.0	3.4	3.6	3.5	3.5
20. Subtotal	8.9	11.8	12.9	13.2	13.8	14.4	13.0	13.8	14.0	15.0
C. Other expenditures on car operation										
21. Personal	4.8	5.5	6.0	6.5	6.8	7.3	8.4	9.8	10.9	11.6
22. Residual (business and government)	2.1	2.3	2.5	2.6	2.7	2.7	3.1	3.9	4.1	4.1
23. Subtotal	6.9	7.8	8.5	9.1	9.5	10.0	11.5	13.6	15.0	15.7
24. Total (17+20+23)	**27.2**	**31.8**	**31.6**	**35.5**	**39.9**	**45.2**	**47.3**	**52.8**	**56.8**	**58.8**
IV. Government capital and operating expenditures to support transportation										
A. Total transportation expenditures										
25. Federal	2.4	2.1	2.6	3.0	3.5	3.3	3.4	3.5	3.5	3.4
26. Provincial/local	6.6	7.4	8.4	8.2	8.1	9.1	8.9	9.2	9.4	10.8
27. Road policing and safety	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.0
28. Subtotal	9.5	10.0	11.6	11.8	12.4	13.1	13.1	13.6	13.8	15.1
29. Subsidies to common carriers	1.3	1.7	2.0	2.1	1.8	2.0	2.2	2.4	2.5	2.7
30. Total (28–29)	**8.2**	**8.4**	**9.5**	**9.7**	**10.6**	**11.2**	**10.9**	**11.2**	**11.3**	**12.5**

Table 1(2)-1 (cont'd)

RESOURCES DEVOTED TO TRANSPORTATION, 1980–1989
($ BILLIONS, CURRENT DOLLARS)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
V. Deductions to eliminate double counting										
A. Government transportation revenues										
31. Motive fuel taxes	1.7	2.3	2.6	2.7	2.7	3.0	3.6	4.9	5.0	4.9
32. Air transportation tax	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.5
33. Motor vehicle permits	1.2	1.3	1.3	1.3	1.5	1.5	1.6	1.8	1.9	2.0
34. Other air revenues	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5
35. Subtotal	3.3	4.0	4.3	4.5	4.7	5.2	5.9	7.5	7.9	8.0
B. Transport inter-industry requirements and transport margins										
36. Carriers	2.3	2.5	2.4	2.6	3.1	3.4	3.5	3.7	3.9	4.1
37. Business — own account	1.1	1.0	0.9	1.0	1.1	1.2	1.3	1.5	1.5	1.5
38. Consumers — own account	1.2	1.2	1.1	1.2	1.4	1.7	1.9	2.0	2.2	2.3
39. Subtotal	4.6	4.7	4.4	4.8	5.6	6.3	6.8	7.2	7.6	8.0
40. Total deductions (35+39)	**7.9**	**8.7**	**8.7**	**9.3**	**10.3**	**11.5**	**12.7**	**14.7**	**15.5**	**15.9**
VI. Total resources devoted to transportation										
41. Grand total (8+14+24+30–40)	**55.6**	**63.2**	**65.0**	**70.5**	**77.4**	**84.7**	**86.6**	**93.1**	**98.4**	**103.1**
42. GDP at market prices	309.9	356.0	374.4	405.7	444.7	478.0	505.7	551.6	605.9	649.9

Notes and Sources to Table 1(2)-1

I. Transportation services produced by businesses for sale (carrier revenues including government subsidies)

1. *Air: 1980–1989:* Statistics Canada, *Air Carrier Financial Statements/Canadian Civil Aviation*, Catalogue No. 51-206, Table 1 (1980–1981), Table 3 (1982–1987), and Table 3.1 (1988–1989).

2. *Rail: 1980–1987:* Statistics Canada, *Rail in Canada 1987*, Catalogue No. 52-216, November 1989, Figure 1.2, page 28; *1988–1989:* Statistics Canada, *Rail in Canada 1989*, Catalogue No. 52-216, October 1991, Figure 2.1, page 26.

3.   *Marine: 1980–1989:* Statistics Canada, *Shipping in Canada*, Catalogue No. 54-205, Table 2, line 14 (1980–1984), Figure 8.5 (1985), and Figure 8.3 (1986–1989).

4.   *Trucking: 1980–1983:* Statistics Canada, *Trucking in Canada*, Catalogue No. 53-222, Table 7, line 4 (Freight Movers), and Text Table XIV, line 8 (1980–1981), and Text Table I, line 8 (1982–1983) (Household Goods Movers); *1984–1989:* Statistics Canada, *Trucking in Canada*, Catalogue No. 53-222, Figure 2.8, line 4 (1984–1988), Figure 2.26, line 4 (1989).

5   *Intercity bus/urban transit: 1980–1989:* Statistics Canada, *Passenger Bus and Urban Statistics*, Catalogue No. 53-215.

6.   *Taxicabs: 1980–1987:* Statistics Canada, *The Input-Output Structure of the Canadian Economy 1987*, Catalogue No. 15-201, February 1991, Table A; *1988:* Statistics Canada, *The Input-Output Structure of the Canadian Economy 1988*, Catalogue No. 15-201, January 1992, Table A.
     Note: The figure shown is for GDP in current dollars at factor cost rather than total revenues. However, most purchased inputs for the taxi industry are in principle included in component III.

7.   *Pipelines: 1980–1987:* Statistics Canada, *Corporation Financial Statistics*, Catalogue No. 61-207, Table 2B; 1988–1989: Estimates based on unpublished material from Statistics Canada.

II. *Transportation services produced on an own account basis — excluding car*

9.   *Private trucking* — based on published data: *1982–1983:* Unpublished data from Statistics Canada; *1984–1988:* Statistics Canada, *Trucking in Canada*, Catalogue No. 53-222.
     Data extrapolated to 1989 (given reduced coverage of 1989 published data) and to 1980 and 1981.

11. *Private marine: 1980–1989:* Statistics Canada, *Shipping in Canada*, Catalogue No. 54-205, Table 2, line 14 (1980–1984), Figure 8.5 (1985), and Figure 8.3 (1986–1989).

12. *Pipelines — own account: 1980–1987:* Statistics Canada, *Corporation Financial Statistics*, Catalogue No. 61-207, Table 2B; *1988–1989:* Estimates based on unpublished material from Statistics Canada.
     Estimate is based on difference between value of sales of products and value of raw materials purchases.

13. *Allowance for private air:* See text — estimate for United States private air is from F. Smith, *Transportation in America* (Eno Foundation, Westport, Conn., May 1990), p. 6.

III. *Car — own account*

A. *Expenditures on new and used (net) motor vehicles*

15. *Personal: 1980–1989:* Statistics Canada, *National Income and Expenditure Accounts, Annual Estimates, 1980–1991*, Catalogue No. 13-201, August 1992, Table 52, pp. 66–67.

16. *Residual:* The difference between 17 and 15.

17. *Subtotal: 1980–1989:* Statistics Canada, *New Motor Vehicle Sales*, Catalogue No. 63-007, Vol. 63, No. 10, August 1992, Table 9.
Adjusted to include an allowance for dealer margins on used cars which would be included in 15 — assumed to be 10% of line 15.

B. Expenditures on gasoline

18. *Personal:* See item 15.

19. *Residual:* The difference between 20 and 18.

20. *Subtotal:* Quantities of gasoline sold — 1980–1989: Statistics Canada, *Road Motor Vehicles, Fuel Sales*, Catalogue No. 53-218, Table 1.
Average fuel prices — *1980–1989:* Unpublished data from Energy, Mines and Resources. The price of regular unleaded gasoline was used to estimate the total value of gasoline sold.
Gasoline for car use is assumed to be 95% of total road gasoline sales less an allowance for share of light truck use not related to passenger transportation (20% of estimated light truck use).

C. Other expenditures on car operation

21. *Personal:* See item 15.

22. *Residual:* The ratio of residual to personal spending for vehicles and fuel combined multiplied by line 21.

IV. Government capital and operating expenditures to support transportation

25. *Federal government expenditures: 1980–1986:* Statistics Canada, *Federal Government Finance, Revenue and Expenditure, Assets and Liabilities,* Catalogue No. 68-211, Table 2; *1987–1989:* Unpublished data from Public Institutions Division, Statistics Canada.

26. *Provincial/local expenditures:*
Residual derived from total consolidated government expenditures on transportation less federal government expenditures. (Thus, the provincial/local expenditures figure is a consolidation of provincial/local expenditures less transfers from federal government tied to transportation programs.)
Total Consolidated Government Expenditures — *1980–1982:* Statistics Canada, *Consolidated Government Finance,* Catalogue No. 68-202, Table 2; *1983–1989:* Unpublished data from Public Institutions Division, Statistics Canada.

27. *Road policing and safety:*
Royal Commission staff estimates — road policing estimate (see section 5.1.4 of Notes to Chapter 3 in this Volume) approximately doubled to allow for other related spending by non-transport departments on motor vehicle registrations, control and safety.

V. Deductions to eliminate double counting

A. Consolidated government transportation revenues

31.   *Motive fuel taxes: 1980–1989:* Statistics Canada, *Public Finance Historical Data, 1965/66–1991/92*, Catalogue No. 68-512, March 1992, Table H1 (Federal) and H3 (Provincial).
        With provincial revenues adjusted approximately to remove revenues that would have been generated if standard provincial sales tax rates were applied to motive fuels (since such fuels are generally exempt from provincial retail sales tax).

32.   *Air transportation tax: 1980–1983:* Statistics Canada, *Consolidated Government Finance*, Catalogue No. 68-202, Table 1 and unpublished material from Public Institutions Division, Statistics Canada; *1984–1989:* Supply and Services Canada, *Public Accounts*, Volume 2, Transport Canada section.

33.   *Motor vehicle permits: 1980–1985:* Statistics Canada, *Consolidated Government Finance*, Catalogue No. 68-202, Table 1 and unpublished material from Statistics Canada; *1986–1990:* Statistics Canada, *National Income and Expenditure Accounts, Annual Estimates, 1980–1991*, Catalogue No. 13-201, August 1992, Table 44, line 15, and Table 45, line 2.

34.   Other air revenues: 1980–1989: Supply and Services Canada, Public Accounts, Volume 2, Transport Canada section.

B. Transport inter-industry requirements and transport margins

        1980–1989: Statistics Canada, *The Input-Output Structure of the Canadian Economy*, Catalogue No. 15-201.

36.   *Carriers:* Based on the ratio of "transportation and storage" and of "transportation margins" used by transport industry to the total output of the transport industry (use Matrix, aggregation "M").

37.   *Business and consumer — own account:* Based on the ratio of transport margins to
and 38. total values of final sales for "motor vehicles and parts" and "motor fuels and lubricants" (final demand matrix, aggregation "M"), multiplied by 2 as a rough allowance for own account transportation inputs (not counted in transportation margins) into these commodities.

42.   *GDP at market prices: 1980–1989:* Department of Finance, *Economic Reference Tables*, August 1992, p. 5.

I. Transportation services produced by business for sale (carrier revenues including direct government subsidies)

The table shows revenues for the major categories of carriers. Sales revenues are used as a measure of total resources devoted to producing these transportation services.

Revenues of travel and ticket agents, and of car and truck rental operations, might also be considered for inclusion in a broad measure of transportation. The data on carrier revenues, however, are generally

reported before deducting commission charges of agents; thus a considerable portion of agent commissions is already included in carrier revenues. Much of the revenues of car and truck rental operations, which totalled about $3 billion in 1989, will in principle be captured in the estimate of resources devoted to private trucking and car use in components II and III.

II. Transportation services produced by businesses for their own account — excluding business use of cars

Businesses and governments devote substantial "in-house" resources to transportation in addition to being major customers for the services of transportation carriers (the latter purchases are included in component I).

These in-house transportation activities are divided into:

- private trucking;
  - based on published data; and
  - adjustment for incomplete coverage
- own account marine transport;
- own account pipeline use; and
- allowance for business aircraft.

As set out in the note on sources to Table 1(2)-1, some data are available for Canada on the first three categories of own account transportation activity. The reported data seem very likely, however, to underestimate substantially the total resources devoted to private trucking. An allowance for incomplete coverage of private trucking is thus added, which is equal to 1% of GDP for all years. This adds an amount somewhat higher than the published data for expenditures on private trucking in the later years covered by the table; it is believed to be a conservative allowance. Road diesel sales not accounted for in the published statistics on diesel fuel use by for-hire truck, private

truck, and bus are roughly equal to the amount that is accounted for by such sales, and are more than twice the level of reported sales to private trucking alone. This suggests that private trucking activity not covered in the official statistics is likely to be larger than private trucking activity which is covered.

There are no comprehensive data on business use of company-owned aircraft. Aviation gasoline sales data coupled with data on fuel consumption by carriers, suggest a substantial level of aviation activity by other than carriers. The allowance made is .1% of GDP, a level somewhat lower than estimates for the United States.

Data on business and government use of cars are not readily available. This category has been dealt with on the basis of overall data on cars, and is included as part of component III.

III. Own account car expenditures

Travel by car is the predominant means of urban and intercity travel in Canada. (As is the practice throughout this report, car refers to both passenger automobiles and light trucks used for passenger transportation purposes.) Data are available for total consumer expenditure on car purchase and operation including maintenance and repairs, fuel, insurance and licence fees. Data are also available which permit estimates of the total value of new car sales, and of gasoline sales.

The residuals, when one deducts the value of car sales (including net sales of used cars) to consumers from the total value of car sales and deducts gasoline sales for car use to consumers from total gasoline sales for car use, provide estimates of business (including car rental operations) and government expenditures on car purchase and fuel. The "residual" for other car operating expenditures is calculated by applying the average ratio of the residual to consumer expenditure for car purchases and fuel purchases, to consumer expenditures for other car operating costs.

The estimates in the table count investment in new cars in the year of purchase, rather than amortizing the price of the car over its life and include an allowance for cost of capital. The latter approach is followed in deriving the cost estimates of car use in Chapter 3 of Volume 1. The two approaches, however, can be expected to produce quite similar results on average although they could diverge substantially in years of cyclically high or low car sales.

No allowance is made in these estimates (or in the cost analysis in Chapter 3 of Volume 1) for any cost of the driver's time.

IV. Government capital and operating expenditures to support transportation

Governments use resources to build and maintain transportation infrastructure including roads and airports, to provide air and marine navigation and traffic control services, and to control and police road traffic.

For purposes of the table, an estimate of total government investment and operating expenditures related to the provision of transportation is required. This estimate is derived using data on total recorded government spending on transportation, plus an estimate of spending on road policing and related government enforcement and safety activities occurring outside of transport departments. Direct government subsidies to transportation carriers are then subtracted from total government expenditure on transportation. (The subsidies have been included in the value of sales of carrier services in component I.) Component IV does not include expenditures by government to purchase or provide transportation for use by government; such expenditures should be covered in components I and III.

Intergovernmental transfers relating to transportation programs are excluded to avoid double counting. The treatment of government transportation investment follows the practice of public accounts, that is, investment is recorded in the year the expenditure is made

rather than amortized over the life of the asset as in the cost estimates of Chapter 3 of Volume 1.

The estimates of expenditures in components I to IV involve some double counting that should be eliminated in order to calculate total resources devoted to transportation.

V. Adjustments to eliminate double counting

The charges, fees and special taxes that governments levy on users of some government-provided transportation facilities, and that cover some of the costs of government transportation services (IV), are included in the prices paid for transportation in components I, II and III. Thus, to add total expenditures on transportation in components I, II and III to government transportation expenditures in component IV, would result in double counting. The table subtracts charges, fees and special taxes that governments levy for use of transportation facilities. These are the infrastructure charges and the special transportation taxes and fees discussed in Chapter 3 of Volume 1, and in Notes to Chapter 3 in this Volume. As in Chapter 3, the amounts of provincial gasoline and other motive fuel taxes in excess of standard rates of general provincial sales taxes are considered to be equivalent to user charges for government-provided transportation facilities for purposes of this table.

A second source of double counting arises because the expenditures in components I to IV include, directly and indirectly, some inputs that are already counted in the sales revenues of common carriers (I). For example, the cost of common carrier services (I) and of own account (II and III) activity includes the cost of gasoline and other fuels, some part of which is the cost of transporting the fuel to where it is sold. Such transportation costs for fuel will already be reflected in (freight) carrier sales revenues. The table thus includes an approximate adjustment, based on Statistics Canada Input-Output Accounts data, to eliminate inter-transportation-industry transportation requirements and transportation margins.

Estimated total resources devoted to transportation (VI) are then calculated as the sum of components I through IV, less adjustments to eliminate double counting (V).

Table 1(2)-2 expresses the dollar estimates from Table 1(2)-1 as percentages of GDP. The 15.9% shown for 1989 in the final line of the table is the basis for the statement in Chapter 1 of Volume 1 that resources equal to about 16% of GDP were devoted to all forms of transportation in that year.

The estimation procedures are viewed as adequate to support the conclusion that a substantial portion of the economy's resources is devoted to providing transportation. For several types of carrier, however, the data used in Table 1(2)-1 and Table 1(2)-2 do not cover small operators and thus tend to under-estimate total transportation provided in the sector. The allowances for lack of coverage of much of private trucking, and of own account aircraft operation, are probably on the low side. The approach would need to be refined before the estimates could be used to draw strong conclusions as to changes in the share of resources devoted to transportation over time, or be used to make precise international comparisons.

Table 1(2)-2
RESOURCES DEVOTED TO TRANSPORTATION AS A PERCENTAGE OF GDP AT MARKET PRICES, 1980–1989
(PERCENT)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
I. Transportation services produced by businesses for sale (carrier revenues including government payments to carriers)										
1. Air	1.3	1.3	1.2	1.2	1.1	1.2	1.2	1.2	1.2	1.2
2. Rail	1.7	1.7	1.7	1.7	1.7	1.6	1.5	1.4	1.3	1.1
3. Marine	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3
4. Trucking	1.8	1.7	1.6	1.5	1.6	1.7	1.7	1.7	1.6	1.6
5. Intercity bus/ urban transit	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.6	0.7
6. Taxicabs	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
7. Pipelines	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
8. Total	6.3	6.3	6.1	6.0	5.9	6.0	5.9	5.7	5.5	5.3

Table 1(2)-2 (cont'd)
RESOURCES DEVOTED TO TRANSPORTATION AS A PERCENTAGE OF GDP AT MARKET PRICES, 1980–1989 (PERCENT)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
II. Transportation services produced on an own account basis — excluding car										
Private trucking 9. Based on published data	1.2	1.1	1.1	1.1	0.9	0.9	0.8	0.8	0.8	0.7
10. Adjustment for incomplete coverage	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11. Private marine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
12. Pipelines — own account	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2
13. Allowance for private air	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
14. Total	**2.7**	**2.7**	**2.6**	**2.6**	**2.4**	**2.4**	**2.2**	**2.2**	**2.1**	**2.0**
III. Car — own account										
A. Expenditures on new and used (net) cars										
15. Personal	2.7	2.5	2.1	2.4	2.7	3.2	3.3	3.3	3.3	3.1
16. Residual (business and government)	1.0	0.9	0.7	0.8	1.0	1.2	1.2	1.4	1.3	1.2
17. Subtotal	3.7	3.4	2.7	3.2	3.7	4.3	4.5	4.6	4.6	4.3
B. Expenditures on gasoline										
18. Personal	1.9	2.2	2.3	2.2	2.2	2.2	1.9	1.8	1.7	1.8
19. Residual (business and government)	1.0	1.1	1.1	1.0	0.9	0.8	0.7	0.6	0.6	0.5
20. Subtotal	2.9	3.3	3.4	3.3	3.1	3.0	2.6	2.5	2.3	2.3
C. Other expenditures on car operation										
21. Personal	1.6	1.5	1.6	1.6	1.5	1.5	1.7	1.8	1.8	1.8
22. Residual (business and government)	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7	0.6
23. Subtotal	2.2	2.2	2.3	2.2	2.1	2.1	2.3	2.5	2.5	2.4
24. Total (17+20+23)	**8.8**	**8.9**	**8.4**	**8.7**	**9.0**	**9.5**	**9.4**	**9.6**	**9.4**	**9.0**

Table 1(2)-2 (cont'd)

RESOURCES DEVOTED TO TRANSPORTATION AS A PERCENTAGE OF GDP AT MARKET PRICES, 1980–1989 (PERCENT)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
IV. Government capital and operating expenditures to support transportation										
A. Total transportation expenditures										
25. Federal	0.8	0.6	0.7	0.7	0.8	0.7	0.7	0.6	0.6	0.5
26. Provincial/local	2.1	2.1	2.2	2.0	1.8	1.9	1.8	1.7	1.5	1.7
27. Road policing and safety	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
28. Subtotal	3.1	2.8	3.1	2.9	2.8	2.7	2.6	2.5	2.3	2.3
29. Subsidies to common carriers	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
30. Total (28–29)	**2.6**	**2.3**	**2.6**	**2.4**	**2.4**	**2.3**	**2.2**	**2.0**	**1.9**	**1.9**
V. Deductions to eliminate double counting										
A. Government transportation revenues										
31. Motive fuel taxes	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.9	0.8	0.8
32. Air transportation tax	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
33. Motor vehicle permits	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
34. Other air revenues	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
35. Subtotal	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.4	1.3	1.2
B. Transport inter-industry requirements and transport margins										
36. Carriers	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.6
37. Business — own account	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2
38. Consumers — own account	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
39. Subtotal	1.5	1.3	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.2
40. Total deductions (35+39)	**2.5**	**2.4**	**2.3**	**2.3**	**2.3**	**2.4**	**2.5**	**2.7**	**2.6**	**2.4**
VI. Total resources devoted to transportation										
41. Grand total (8+14+24+30–40)	**17.9**	**17.8**	**17.4**	**17.4**	**17.4**	**17.7**	**17.1**	**16.9**	**16.2**	**15.9**

2. Comparison With Resources Devoted to Health Care

The discussion of resources devoted to transportation in Chapter 1 of Volume 1 also notes that resources equal to 9% of GDP were devoted to health care in Canada. Health and Welfare Canada has estimated that total public and private expenditures, on capital and operating costs of hospitals and other health care institutions, on physicians' and other health professionals' services, and on pharmaceuticals, equalled 8.7% of GDP in 1989 and 9.2% in 1990 (Policy, Planning and Information Branch, "Canadian Health Care Expenditures" by source of funds and by category, unpublished tables, March 1992). These appear to be conceptually comparable with the estimates of total resources devoted to transportation in Tables 1(2)-1 and 1(2)-2. Virtually all health care expenditures, however, would be classified as final expenditures in the National Income and Expenditure Accounts, unlike the case for transportation where, especially for freight transportation, a substantial portion would be classified as intermediate (an input into the production of other goods and services).

3. Value Added by Transportation Carriers

As noted, the estimate of total resources devoted to transportation presented in Table 1(2)-1 is a broad measure of the size of transportation in the economy. A very different measure, to which reference is more frequently made, is the "share of transportation industries in GDP." "Transportation industries," as defined by Statistics Canada, are basically the transportation carriers plus industries producing certain related services. The GDP of these industries is the value added by firms in the industries; that is, the value of their sales less the value of goods and services purchased from firms in other industries. This essentially represents the value of their wages, depreciation, interest and profits.

Table 1(2)-3 shows Statistics Canada data on GDP (at factor cost in constant 1986 dollars) in the transportation sector as percentages of total GDP (at factor cost in 1986 dollars). The percentage for total

transportation, 4.8% in 1989, is much less than the Table 1(2)-2 estimate for total resources devoted to transportation. The difference reflects both the fact that the latter estimate included own account transportation activity by businesses, governments and, most importantly, consumers in the form of car travel, and the fact that it included total resources used including resources (for example, fuel) purchased from firms in other industries, as well as resources provided directly by transportation firms.

Table 1(2)-3
GROSS DOMESTIC PRODUCT AT FACTOR COST FOR TRANSPORTATION INDUSTRIES, 1980–1989

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
I. GDP at factor cost (billions of dollars at 1986 prices)										
Air	2.3	2.2	2.1	2.3	2.6	2.8	2.9	3.0	3.3	3.3
Rail	3.4	3.4	2.7	2.9	3.7	3.7	3.9	4.1	4.3	4.1
Water	1.2	1.1	1.1	1.3	1.3	1.3	1.3	1.4	1.5	1.5
Truck	4.2	4.3	4.2	4.5	5.3	5.3	5.4	6.0	6.4	6.6
Urban transit	1.7	1.8	1.7	1.7	1.5	1.6	1.6	1.5	1.5	1.5
Interurban bus	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Other transport industries[a]	1.7	1.6	1.5	1.8	2.1	2.2	2.2	2.3	2.3	2.3
Total business sector industries	14.6	14.5	13.6	14.8	16.7	17.0	17.5	18.4	19.5	19.5
Pipeline transport	2.0	1.9	1.9	1.9	2.1	2.1	2.1	2.4	2.8	3.0
Non-business sector industries[b]	2.1	2.1	2.0	2.0	2.0	2.1	1.9	2.0	2.0	2.0
Grand total transport	18.8	18.5	17.5	18.6	20.7	21.2	21.6	22.8	24.3	24.5
Total economy	382.0	397.1	382.6	395.0	418.7	438.5	451.8	470.9	491.0	506.1

Table 1(2)-3 (cont'd)

Gross Domestic Product at Factor Cost for Transportation Industries, 1980–1989

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
II. Percentage shares of GDP for the total economy										
Air	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
Rail	0.9	0.8	0.7	0.7	0.9	0.8	0.9	0.9	0.9	0.8
Water	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Truck	1.1	1.1	1.1	1.1	1.3	1.2	1.2	1.3	1.3	1.3
Urban transit	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3
Interurban bus	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Other transport industries[a]	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total business sector industries	3.8	3.7	3.6	3.7	4.0	3.9	3.9	3.9	4.0	3.9
Pipeline transport	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6
Non-business sector industries[b]	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4
Grand total transport	4.9	4.7	4.6	4.7	4.9	4.8	4.8	4.8	4.9	4.8

Source: Statistics Canada, *CANSIM*, matrix 4671.

a. Other transport industries include taxicab, other transportation, and highway and bridge maintenance industries. This component was calculated residually given the preceding components and the total for business sector industries.

b. Non-business sector industries include establishments, primarily government-owned, which provide services used by transportation carriers, including airport and port operation, and — where carried out by government departments — highway, street and bridge maintenance.

Note: Components may not add exactly to totals due to rounding.

4. Estimate of Resources Devoted to Intercity Passenger Transportation

Part A of Table 1(2)-4 shows estimates of the intercity passenger transportation share of the total carrier revenues in component I of Table 1(2)-1, and repeats from Table 1(2)-1 the allowance for use of company-owned aircraft — all of which is assumed to be for intercity

passenger purposes. Also shown are two estimates of the intercity share of car use. These shares are intended to correspond to a broad definition of intercity car travel — (a) — all car travel on provincial highways, and a narrower definition — (b) — use of highways for trips extending beyond a single metropolitan or urban area.

The share corresponding to the broad definition (a) is defined using the ratio of estimated car vehicle-kilometres on provincial highways to total car vehicle-kilometres from Table 2(2)-A1, in the Annex to Notes to Chapter 2 in this volume. This ratio — 54.2% — is applied to total own account car expenditures (line 24) from Table 1(2)-1. The estimate for the narrower definition (b) is simply two thirds of the broad estimate — the same ratio as used in Notes to Chapter 2 in estimating car passenger-kilometres corresponding to the narrower definition of intercity travel.

Finally, Table 1(2)-4 includes an approximate allowance for the intercity passenger travel share of government transportation expenditures. For the purposes of this table, the estimate of relevant government transportation expenditures is defined using the ratio of non-government expenditures on intercity passenger travel (the sum of lines 5, 6 and 7 in Table 1(2)-4, or of lines 5, 6 and the value corresponding to line 7 for narrow intercity car use) to total non-government expenditures on transportation (the sum of lines 8, 14 and 24 in Table 1(2)-1). This ratio is applied to government capital and operating expenditures to support transportation net of government transportation charges (line 30 less line 35 from Table 1(2)-1).

A more painstaking, although still approximate, allocation of total government transportation expenditures to intercity passenger transportation was used to estimate government infrastructure costs for purposes of the modal cost comparisons in Chapter 3 of Volume 1 (further discussed in Notes to Chapter 3 in this Volume). However, to estimate an approximate overall share of resources devoted to intercity passenger transportation, the above procedure was considered adequate.

Table 1(2)-4

RESOURCES DEVOTED TO INTERCITY PASSENGER TRANSPORTATION, 1980–1989

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
A. $ billions, current dollars										
Carrier intercity passenger services (including government payments to carriers)										
1. Air	3.2	3.8	3.9	3.8	4.2	4.6	5.0	5.3	6.0	6.6
2. Rail	0.6	0.8	0.7	0.8	0.7	0.9	0.8	0.8	0.9	0.8
3. Ferries	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
4. Intercity bus	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5. Total	**4.3**	**5.1**	**5.1**	**5.1**	**5.4**	**6.0**	**6.3**	**6.7**	**7.5**	**8.0**
6. Allowance for private air	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6
Own account intercity car										
7. Broad measure (a)	14.7	17.3	17.1	19.2	21.6	24.5	25.7	28.6	30.8	31.9
Government capital and operating expenditures to support intercity passenger transportation net of transportation taxes/charges										
8. Corresponding to broad measure of intercity car (a)	1.7	1.6	1.9	1.8	2.1	2.2	1.8	1.4	1.3	1.7
Total expenditures in intercity passenger transportation										
9. Carrier, air, plus broad intercity car (a)	21.1	24.2	24.5	26.6	29.5	33.2	34.3	37.2	40.1	42.2
10. Carrier, air, plus narrow intercity car (b)	15.6	18.0	18.1	19.6	21.6	24.3	25.1	27.2	29.5	31.0
11. GDP at market prices	309.9	356.0	374.4	405.7	444.7	478.0	505.7	551.6	605.9	649.9

Table 1(2)-4 (cont'd)
RESOURCES DEVOTED TO INTERCITY PASSENGER TRANSPORTATION, 1980–1989

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
B. Percentages of GDP at market prices										
Carrier intercity passenger services (including government payments to carriers)										
1. Air	1.0	1.1	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0
2. Rail	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
3. Ferries	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4. Intercity bus	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
5. Total	**1.4**	**1.4**	**1.4**	**1.3**	**1.2**	**1.3**	**1.2**	**1.2**	**1.2**	**1.2**
6. Allowance for private air	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Own account intercity car										
7. Broad measure (a)	4.8	4.8	4.6	4.7	4.9	5.1	5.1	5.2	5.1	4.9
Government capital and operating expenditures to support intercity passenger transportation net of transportation taxes/charges										
8. Corresponding to broad measure of intercity car (a)	0.6	0.4	0.5	0.5	0.5	0.5	0.4	0.2	0.2	0.3
Total expenditures on intercity passenger transportation										
9. Carrier, air, plus broad intercity car (a)	6.8	6.8	6.5	6.6	6.6	6.9	6.8	6.7	6.6	6.5
10. Carrier, air, plus narrow intercity car (b)	5.0	5.0	4.8	4.8	4.9	5.1	5.0	4.9	4.9	4.8

Notes and Sources to Table 1(2)-4

Carrier intercity passenger services plus car rental

1.   *Air: 1980–1987:* **Unpublished data from Statistics Canada;** *1988–1989:* **Statistics Canada,** *Canadian Civil Aviation,* **Catalogue No. 51-206, Table 3.1.**

2.   *Rail: 1980–1981:* **Statistics Canada,** *Railway Transport: Part II, Financial Statistics,* **Catalogue No. 52-208, Table 2;** *1982–1986:* **Statistics Canada,** *Railway Transport in Canada: General Statistics,* **Catalogue No. 52-215, Table 2;** *1987–1989:* **Unpublished data from Statistics Canada.**
Passenger revenues of VIA Rail and other intercity rail carriers plus VIA Rail operating subsidy from above sources. Adjusted to include government capital grants to VIA Rail, and to assume that ratio of subsidy (including capital grants) for other intercity passenger operations to passenger revenues is the same as for VIA Rail.

3.   *Ferries: 1980–1989:* Unpublished material from Statistics Canada, and carrier annual reports.
     Revenues from transportation of passengers and passenger vehicles, plus a pro rata share of subsidies.

4.   *Intercity Bus:* Where possible, intercity revenues from all sources, and not just inter-city bus establishments, have been collected. Intercity data are found in the operating and income accounts of the four types of bus establishment (i.e. Intercity, Urban, School Bus, Other) in Catalogue No. 53-215 from 1980–1989.

6.   *Allowance for private air:* See text.

7.   *Own account intercity car:* 54.2% of line 24 from Table 1(2)-1. See text.

Government capital and operating expenditures to support intercity passenger transportation net of transportation taxes/charges

    Net government expenditures (i.e. line 30 to line 35 of Table 1(2)-1) times the ratio of intercity private expenditures from Table 1(2)-4 to total private expenditures from Table 1(2)-1. See text.

Part B of Table 1(2)-4 shows the Part A dollar estimates expressed as percentages of GDP. The 1989 shares, rounded, are 5% for the narrower definition of intercity passenger transportation (b) and 7% for the broad definition (a). This is the basis for the percentages in Chapter 1.

An alternative broad estimate of total costs of domestic intercity passenger transportation may be obtained in Table 3-1(b) in Chapter 3. For 1991, this estimate — $43 billion — is 6.4% of GDP. The basis for this alternative estimate differs in a number of respects from that for the estimate in Table 1(2)-4. The alternative includes an estimate of environmental costs associated with intercity passenger transportation, but excludes the costs of international air travel. The alternative uses an annual stream of costs for capital used in transportation by consumers and governments, rather than expenditures on new capital in the year in question.

NOTES TO CHAPTER 2:
ESTIMATES OF INTERCITY PASSENGER TRAVEL

INTRODUCTION

In describing the current situation of Canadian domestic intercity passenger transportation, and in briefly putting this situation in historical and international perspective, the text, charts and tables in Chapter 2 of Volume 1 present estimates for a number of aspects of passenger transportation, particularly when comparing the roles of the different means of transportation. In many cases, it is unfortunately not a question of simply reproducing data from official sources. Rather, Royal Commission staff have developed estimates for various aspects of passenger travel from a variety of sources. Development of the estimates often involves making assumptions that are based in part on judgement rather than solid evidence, and may involve a substantial element of approximation. The sections of these Notes to Chapter 2 are intended to set out the bases for the estimates used in Chapter 2, to report the estimates in fuller detail in a number of the cases, and to provide some additional discussion of conclusions to be drawn from the estimates.

Section 1 — Measures of the Shares of Different Means of Transportation in "Intercity Travel" — deals with the estimates of the current (1990) levels of Canadian domestic intercity passenger transportation provided by car, air, bus, train and ferry. The section refers briefly to charter/tour/cruise travel by bus and ship, which are not included in the basic estimates. Annex 1, at the end of these Notes to Chapter 2, provides a fuller explanation and reporting of estimates of total travel and total highway travel, by car.

Section 2 — Estimates of Domestic Intercity Passenger Transportation Modal Shares, 1930–1990 — explains the basis for, and comments on, the historical estimates of passenger-kilometres of domestic intercity travel by car, air, bus and rail for the period from 1930 to 1990.

Section 3 — International Comparisons of Modal Shares in Passenger Transportation — explains the basis for and comments on comparative estimates of distance travelled by car, airplane, bus and train for Canada, the United States, Japan, France, West Germany and the

United Kingdom. These estimates are for total domestic travel, not just domestic intercity travel, as reasonably comparable international information is only available for total domestic travel.

Sections 2 and 3 do not include travel by ferry. While it can be an important link in intercity travel, it generally accounts for only a fraction of 1% of total intercity distance travelled (passenger-kilometres).

Section 4 — Importance of Long and Short Trips in Domestic Intercity Travel — like Section 1, this section deals with current Canadian domestic intercity passenger transportation. It briefly presents some further information on the relative importance in total domestic travel of trips of different lengths.

1. MEASURES OF THE SHARES OF DIFFERENT MEANS OF TRANSPORTATION IN "INTERCITY TRAVEL"

Chapter 2 states that Canadians took over 150 million intercity trips in 1990, of which 134 million were in Canada. The chapter mentions the shares of trips and of total distance travelled for which the different means of passenger transportation account. This section provides a more detailed discussion of data on domestic intercity travel and describes the development of estimates of some aspects of intercity travel for which direct data are not available.

Information on the amount of intercity travel by the different means of passenger transportation helps provide a general understanding of the relative roles of the different means, of changes in these roles over time, and of differences across countries in the roles played by the different means. As is often the case with general descriptive statistics, however, a number of somewhat arbitrary choices have to be made regarding the basis on which to assemble the data. It is not always possible to find a single basis that is fully appropriate for the different purposes for which the statistics may be used. As well, basic data on some aspects of intercity travel, especially travel by car, are scarce. While estimates of total travel by each means are

provided, in some cases the estimates are no more than informed guesses. They should be viewed as providing an indication of the broad picture, not as precise measures.

"Intercity" travel may be **defined** either in terms of characteristics of the trip, typically trips in excess of a specified length, or in terms of the means of travel used — air, train (or train other than specified commuter trains), intercity bus (as opposed to urban and suburban transit), specified types of ferries, and car travel involving specified classes of roads. The amount of intercity travel by any means of transportation can be **measured** in terms of number of trips, in terms of distance travelled (for example, passenger-kilometres), or conceivably in terms of total spending on travel by the means. With respect to both the definitions and the measures, it is often difficult to find an approach that treats the different means of transportation in a reasonably comparable manner.

There are further definitional issues to be resolved. Should travel include "cruise" or "tour" type trips? The main estimates generally exclude boat cruises, charter bus trips and "tourist trains"; in other words, the focus is on travel whose main purpose is to get from point A to point B. Supplementary information is provided, however, on some elements of cruise travel in subsection 1.5. If one is assembling data on domestic travel, which is the subject of this section, a further issue is the treatment of the domestic portion of international trips.

As discussed in the section entitled "A Data Detour" of *Getting There: The Interim Report of the Royal Commission on National Passenger Transportation* (pages 56–61), there are two basic sources of data on domestic travel in Canada: Statistics Canada's Canadian Travel Survey (CTS), which asks a sample of Canadians about the intercity trips they have taken over the previous three months, and data reported by carriers on passengers carried. For travel by car, the CTS provides some data, but car data that correspond directly to the carrier data for the public means of travel do not exist. For private car use, information on volume of traffic on highways or, failing that, on fuel consumption and on motor vehicle registrations

provides a partial parallel to the carrier data for the public means of passenger transportation.

The CTS provides an estimate of domestic (and international) trips taken in excess of 80 kilometres in one-way distance. The trip is identified by the primary means used. Thus, as noted in the Interim Report, a trip from Victoria to Kingston that involves travel by bus and ferry from Victoria to Vancouver, by airplane from Vancouver to Toronto, and by train from Toronto to Kingston would be recorded as one air trip. Estimates are provided of both numbers of trips and total passenger-kilometres travelled.

The estimates of total travel by the different means of transportation are certainly of interest, but they give an incomplete view of intercity travel in Canada for a number of reasons:

- As illustrated by the Victoria to Kingston example, information on the role of any secondary modes used in the course of a trip is not provided.

- Travel within Canada by residents of other countries is not included.

- Respondents to the CTS may fail to recall some trips, especially shorter car and bus trips.

- Finally, information on trips under 80 kilometres in length would be useful for some purposes. Such trips likely account for a significant portion of the business of the ferry and intercity bus industries, some of the business of the passenger rail industry, and a substantial portion of use of highways by cars.

Table 2(2)-1, which is an update of Table III-1 of the Royal Commission's Interim Report, shows 1990 estimates of domestic intercity trips or of passengers carried, and of passenger-kilometres travelled, from the Canadian Travel Survey and from carrier data or other sources. As indicated earlier, the carrier data, and the alternative car passenger-kilometre estimate, are more inclusive. They are attempts to measure all domestic travel excluding travel within a single urban or metro-politan area and short car trips on secondary rural roads.

Table 2(2)-1
INFORMATION ON DOMESTIC INTERCITY TRAVEL
(FROM ALTERNATIVE SOURCES, 1990)

	Car	Air	Intercity bus	Rail (excluding com- muters)	Intercity ferries	Total
I. Trips (one-way) or passengers carried						
CTS-based estimates one-way trips						
millions	243	13.1	7.5	1.6	0.7	266[a]
percentage	91%	5%	3%	1%	0%	100%
Carrier-based estimates passengers carried						
millions	n/a	14.1	18.2	3.8	23.5	n/a
II. Passenger-kilometres						
CTS-based estimates						
billions	56.7	20.8	2.4	0.6	0.2	80.7
percentage	70%	26%	3%	1%	0.3%	100%
Carrier plus alternative car estimates						
billions	135	25.0	3.4	1.4	0.8	166
percentage	82%	15%	2%	1%	0.5%	100%
III. Implicit Average Trip Length						
CTS-based estimates						
kilometres	234	1,580	325	403	298	304
Alternative estimates						
kilometres	n/a	1,774	187	368	34	n/a

a. This figure is slightly less than twice the estimate of 134 million domestic round trips referred to in Chapter 2. The latter figure includes travel by other and unspecified means.

1.1 CANADIAN TRAVEL SURVEY ESTIMATES OF TRIPS AND PASSENGER-KILOMETRES

CTS-based estimates of trips are the CTS survey figures for round trips (Statistics Canada, Catalogue No. 87-504) multiplied by two to obtain one-way equivalent figures for comparison with the carrier-based estimates of passengers carried. The CTS-based estimate of passenger-kilometres is taken from unpublished CTS survey results.

1.2 CARRIER-BASED ESTIMATES — PASSENGERS CARRIED

1.2.1 Air

Statistics Canada, *Air Passenger Origin and Destination, Domestic Report 1990*, Catalogue No. 51-204, August 1991, Table 3, reports 13 million domestic origin-destination (O-D) trips in 1990. This report, based on data from the "Scheduled Air Passenger O-D Survey," records the total number of trips flown between city-pairs on a subset of large domestic carriers. Since it only includes passenger trips on the scheduled services of nine major airlines, the report underestimates the number of total trips. Data on domestic charter activity and O-D trips entirely on smaller airlines should also be considered.

Statistics Canada, *Air Charter Statistics 1990*, Catalogue No. 51-207 reports that in 1990 almost 330,000 trips were taken aboard domestic charters.

In addition, Statistics Canada's unpublished "System Passenger Origin and Destination Survey" showed that in 1990 almost 3 million O-D trips were taken on the smaller regional and local air carriers in Canada. Only a portion of these trips, however, can be considered as additional trips since many of these smaller airlines interline with the carriers counted by the "Scheduled Air Passenger O-D Survey." In an interline arrangement, passengers from one carrier transfer to another carrier and continue their journey. For example, a passenger flying First Air from Iqaluit, N.W.T., to Ottawa then transferring to Air Canada in Ottawa and continuing to Toronto would be counted as a Scheduled O-D Survey passenger from Iqaluit to Toronto because the itinerary includes a flight stage aboard Air Canada's system. A passenger flying First Air from Iqaluit to Yellowknife would not appear in the Scheduled Air Passenger O-D Survey but would be counted by the System O-D Survey, which measures the scheduled O-D traffic within route systems of all Levels 2 to 5 airlines. There are no data on how many trips recorded by the Scheduled Air Passenger O-D Survey involve smaller carriers. Following the approach of an unpublished

Statistics Canada study, one quarter of the System O-D trips for carriers not included in the Scheduled O-D Survey are counted as separate trips. This amounted to over 700,000 trips in 1990.

Adding the domestic charter O-D trips and the allowance for trips on smaller carriers to the reported 13 million O-D trips yields an overall estimate of 14.1 million trips.

1.2.2 Intercity Bus

Bus trips for 1990 were estimated by reducing the 1989 passenger level for the intercity passenger bus industry (Statistics Canada, *Passenger Bus and Urban Transit Statistics*, Catalogue No. 53-215) by 7%, the average annual rate at which passengers carried fell between 1984 and 1989. This results in an estimate of 16 million passengers. In addition, bus operators classified as school bus operators, and as charter and sightseeing bus operators also offer some scheduled intercity bus services. Unfortunately, only vehicle-kilometres are recorded for these firms. In order to derive an estimate of passengers carried by these firms, an assumed occupancy rate of 21 passengers per bus was used. Secondly, passengers were assumed to have an average trip length of 100 km — half that estimated for the intercity passenger bus industry. This yields an estimate of 2 million passengers carried on other scheduled services or 14% of the intercity bus industry figure. The overall estimate of intercity bus passengers is 18.2 million.

1.2.3 Rail

The rail passengers figure is the sum of VIA Rail passengers (Statistics Canada, *Rail in Canada 1990*, Catalogue No. 52-216, Figure 3.10), and unpublished statistics for other intercity railways. Commuter services are excluded. In 1990, about 3.8 million passengers were carried, a significant reduction from 1988, reflecting the elimination of about half of the VIA Rail network.

1.2.4 Intercity Ferries

Intercity ferry passengers carried include all domestic passengers on BC Ferries, Marine Atlantic, Northumberland Ferries, other Atlantic region ferries, Ontario Northland, and the longer St. Lawrence River crossings, primarily those of the Société des Traversiers du Québec. Data were obtained either from annual reports or directly from the carriers. In 1990, these services together transported about 23.5 million passengers.

1.3 CARRIER-BASED ESTIMATES — PASSENGER-KILOMETRES

1.3.1 Air

Domestic air passenger-kilometres are taken from Statistics Canada, *Canadian Civil Aviation 1990*, Catalogue No. 51-206, November 1991, Table 2.2. Data include both scheduled and charter domestic passenger-kilometres of Levels 1 to 4.

1.3.2 Intercity Bus

The bus passenger-kilometres figure is an estimate derived using 1989 data on bus-kilometres for intercity passenger bus operators and for other passenger bus operators that offer scheduled intercity services (for example, school bus, and charter and sightseeing establishments), together with an assumed average occupancy rate (passengers per bus). In 1989, intercity services produced almost 170 million bus-kilometres. Assuming an occupancy of 21 passengers per bus,[1] yields an estimate of over 3.5 billion passenger-kilometres. Bus passenger-kilometres have been falling steadily at about 3% per annum since the mid-1980s; the estimate for 1990 is thus about 3.4 billion passenger-kilometres.

1.3.3 Rail

The rail passenger-kilometres figure is the sum of statistics for VIA Rail (Statistics Canada, *Rail in Canada 1990*, Catalogue No. 52-216, Figure 3.10) and unpublished data on the other intercity railways.

Commuter services are again excluded. In 1990, about 1.4 billion passenger-kilometres were recorded, a significant reduction from 1988.

1.3.4 Intercity Ferries

Ferry passenger-kilometres are calculated using the number of passengers carried on each route and an estimate of the average distance sailed on the route. This yields an estimate for 1990 of about 0.8 billion passenger-kilometres.

1.4 ALTERNATIVE ESTIMATE OF CAR PASSENGER-KILOMETRES

The estimate is simply two thirds of the Royal Commission staff estimate of 205 billion passenger-kilometres for total car travel on highways (including use of small vans and light trucks for passenger transportation purposes). The basis for the total highway travel estimate is described in Annex 1. The estimate of total car travel on highways is itself subject to a considerable range of uncertainty, particularly in the assumption as to the average number of people occupying a car during highway travel. Multiplication by the two-thirds factor makes a very rough allowance for the fact that provincial highways that pass through metropolitan areas are often heavily used for urban travel. Thus, a considerable fraction of total highway use consists of trips that are not intercity but are entirely within metropolitan areas.

The carrier and alternative car estimates are considerably higher than the CTS estimates for all modes except air. Because they give a more complete — although in some cases very approximate — view of the role of the different modes, they receive primary emphasis in most of the following sections of these Notes to Chapter 2.

The 70% estimate from the CTS of the share of the car in intercity passenger-kilometres should be considered a minimum estimate. It seems very likely that a larger fraction of car trips than of trips by other modes, especially air, are missed from the survey due to failure

of the respondent to recall all trips taken. Further, as noted earlier, for some purposes there is interest in trips under 80 kilometres in one-way distance, of which the car would be expected to have an over-whelming share, followed by bus. The rough alternative estimates of intercity car passenger-kilometres, when combined with the other carrier-based estimates, result in a car share of 82%. The very approxi-mate nature of the allowance for the intercity share of total highway travel is reflected in the reference in the section "How Canadians Travel," in Chapter 2 of Volume 1, to car travel as accounting for "around 80 percent of all domestic intercity passenger-kilometres travelled in Canada."

1.5 TOUR/CRUISE TRAVEL

As noted, Table 2(2)-1 is intended to cover intercity travel, rather than specialized sightseeing tours or cruises. In part this is because sight-seeing tours do not generally provide an effective alternative for people whose main objective is to travel from point A to point B. Some bus group charters, however, may be a substitute for use of public carriers. Data on numbers of tour/cruise passengers and passenger-kilometres tend to be even sketchier than other travel data.

The "carrier-based," and presumably the "CTS-based," estimates in Table 2(2)-1 do include domestic air travel by "charter services" — where charter in this case refers to aircraft operators who sell indivi-dual seats in an aircraft flying at times specified by the operator. (The table does not include air travel on small chartered aircraft where the aircraft itself is chartered to take the travellers to a destination on a schedule specified by the travellers.)

The carrier-based estimates in Table 2(2)-1 include little if any travel by "tour trains." Until recently, tour trains have generally been confined to short day trips, but with the Rocky Mountaineer service, and potentially other services in the future, this type of train travel may become more important.

The bus and boat estimates are more substantially affected by the treatment of charter/tour/cruise travel. Some charter/tour/cruise travel by bus and boat is presumably included in the CTS-based estimates (the "ferries" heading should read "boat" as far as the CTS estimates are concerned). For bus, as shown later, the number of bus-kilometres of service provided by operators that specialize in charter services is more than one third the level of bus-kilometres in intercity service by intercity bus operators. As charter services almost certainly operate with higher average occupancy rates, in passenger-kilometre terms they may well equal half or more of the scheduled intercity level. The table shows a set of estimates of non-urban charter activity, together with the assumptions on which the estimates are based.

With about 200,000 passengers,[2] cruise ship operations in Canadian waters may well generate revenues of the same order as intercity ferry operations ($300 million a year). The number of cruise passengers is divided about 90% west coast and 10% inland and east coast. The cruise industry includes excursion boats, with no overnight accommodation, and cruise ships. The passenger and rough revenue estimates given earlier, however, do not include day excursion operations.

Cruise, as opposed to excursion, ships are mainly foreign registered (foreign flag), built and crewed. Most of them are operated by foreign companies although some may be under charter to Canadian companies. The Canadian registered ships are the smaller ones and generally sail on the Great Lakes, St. Lawrence and east coast. Recent changes to legislation permit foreign registered ships above 250 berths to engage in international cruise service but reserve to Canadian registry service by vessels of 250 berths or less.

Operator	Intercity scheduled service		Charter (non-urban)[a]	
	bus-km	pass-km[b]	bus-km	pass-km[c]
Intercity bus class 1 and 2	156	3,276	20[d]	692
Other passenger bus[e]	6	126	49	1,711
School bus[e]	5	105	[f]	
Intercity bus class 3[g]	2	42		
Total	169	3,549[h]	69	2,403

Source: Derived from data from Statistics Canada, *Passenger Bus and Urban Transit Statistics*, Catalogue No. 53-215, 1989.

a. The charter total is reduced by 25% as a rough allowance for local (urban) activity.
b. Assuming an average load of 21 passengers.
c. Assuming an average load of 35 passengers.
d. Calculated from the proportion of charter revenues to unit toll revenues.
e. School busing not included.
f. Although school bus charters do on occasion range beyond the 80 km threshold, this class of operators has been excluded as constituting primarily local activity.
g. Estimated from 1988 data (Class 3 data were dropped in 1989).
h. This figure, reduced by the recent average annual rate of decrease, is the basis for the estimate of 1990 intercity bus passenger-kilometres in Table 2(2)-1.

2. ESTIMATES OF DOMESTIC INTERCITY PASSENGER TRANSPORTATION MODAL SHARES, 1930–1990

Chart 2-5, in Chapter 2, shows rough estimates of the car, bus, rail and air shares, measured in passenger-kilometres, of Canadian intercity transportation over the last 60 years. As discussed in Section 1 of Notes to Chapter 2, the estimate of passenger-kilometres of intercity travel by car is very rough. The widest margins of uncertainty arise due to lack of good information on the average number of persons occupying cars when they are used for intercity travel, and on the fraction of car travel on highways that is intercity in nature. The estimate of passenger-kilometres of intercity travel by bus is also subject to significant uncertainty. Thus Chart 2-5 and the tables in this section only provide a very general indication of past trends — not precise estimates.

2.1 BASIS FOR ESTIMATES

As will be set out in more detail later, reasonably good data on air and rail passenger-kilometres of travel exist for most or all of the historical period under consideration. For car and bus, however, there are no data that directly measure travel. In these latter cases, the extrapolation backwards from the present is based on other statistical series, such as fuel consumption, which shed some light on the way the total amount of travel by these means has changed over time.

2.1.1 Car

The very approximate backwards extrapolation of the level of inter-city car travel in effect makes use of historical data on gasoline sales, estimates of the fraction used in cars, and estimates of average fuel economy, to produce estimates of changes in car vehicle-kilometres. Then, multiplying by an index of assumed occupancy rates provides estimates of changes in passenger-kilometres of travel. The derivation of the estimates for passenger automobiles is set out in more detail later. Component historical series used are shown in Table 2(2)-3. (The explanation is organized in terms of the columns in the table.)

1. Data on sales of gasoline in Canada taxed for use by road motor vehicles are available for the full period covered. For the period 1977 to 1989, however, the source data do not include gasoline sales in Alberta and/or Saskatchewan for years in which no gasoline taxes were levied. The series shown in the table, however, has been adjusted to include an approximate allowance for sales in these provinces over the periods in which taxes were not levied.

2. In the absence of extended Canadian historical data series on the fraction of gasoline sales for use in automobiles, it is assumed that the Canadian fraction changed in proportion to the corresponding fraction for the United States. Data on total gasoline sales for road motor vehicles, and for automobiles, for the United States are available from 1948 to 1990. As well, closely related data are available for earlier years; this allows an approximate series to be produced for the years prior to 1948.

Table 2(2)-3
Series Used to Extrapolate Backwards the 1990 Estimate of Automobile Passenger-Kilometres

Year	(1) Net sales of gasoline for road motor vehicles — Canada (billions of litres)	(2) Auto gasoline sales as share of road gasoline sales — U.S. (%)	(3) Auto fuel effi-ciency — U.S. (litres/100 km/per vehicle)	(4) Index of vehicle-kilometres $((1 \times 2) \div 3)$ (1990= 100)	(5) Population per registered auto — Canada (persons per car)	(6) Index of occu-pancy rate — Canada (1990= 100)	(7) Index of passenger-kilometres (4×6) (1990= 100)
1930	2.1	77.2	15.4	5.7	9.6	148.3	8.4
1932	2.1	76.7	15.4	5.6	11.1	148.3	8.3
1934	2.2	76.2	15.4	5.8	11.2	149.7	8.6
1936	2.4	75.7	15.4	6.4	10.5	149.0	9.5
1938	2.9	75.1	15.4	7.5	9.6	148.3	11.2
1940	3.2	74.6	15.4	8.3	9.2	147.0	12.2
1942	2.8	72.9	15.5	7.0	9.6	146.3	10.3
1944	2.6	68.2	15.7	6.1	10.1	147.0	9.0
1946	4.5	73.8	15.8	11.5	10.0	147.7	16.9
1948	5.2	71.0	15.8	12.5	8.6	145.6	18.2
1950	6.3	69.1	15.8	14.9	7.2	143.6	21.4
1952	7.8	70.3	16.1	18.4	6.3	140.3	25.8
1954	9.2	71.3	16.2	21.8	5.6	138.3	30.2
1956	11.2	72.3	16.4	26.5	5.0	136.2	36.1
1958	12.4	73.8	16.5	30.0	4.7	134.2	40.2
1960	13.7	74.2	16.5	33.2	4.4	132.9	44.1
1962	14.8	74.4	16.4	36.2	4.1	131.5	47.6
1964	16.8	74.0	16.5	40.5	3.8	129.5	52.4
1966	19.4	78.5	16.7	49.3	3.7	127.5	62.8
1968	21.6	79.1	17.0	54.4	3.4	125.5	68.2
1970	24.1	79.2	17.4	59.1	3.2	122.8	72.5
1972	26.9	79.0	17.6	65.2	2.9	120.1	78.4
1974	30.3	77.8	17.5	72.5	2.6	116.8	84.6
1976	32.4	75.9	17.4	76.3	2.6	112.8	86.0
1978	34.7	72.8	16.8	81.2	2.4	109.4	88.8
1980	35.7	71.0	15.2	89.9	2.3	107.4	96.5
1982	31.2	71.1	14.1	84.6	2.3	106.0	89.7
1984	30.4	67.8	13.2	84.0	2.3	104.0	87.3
1986	30.5	66.7	12.9	85.2	2.2	104.0	88.6
1988	32.1	65.5	11.8	95.6	2.1	102.0	97.5
1990	31.8	65.7	11.2	100.0	2.1	100.0	100.0

Sources: *Fuel sales — Canada:* 1930–1944: Dominion Bureau of Statistics, *Highway and the Motor Vehicle in Canada*, Catalogue No. 53-201, 1938 and 1944 editions. 1945–1955: D.B.S., *Motor Vehicle*, Catalogue No. 53-203, 1950 and 1955 editions. 1956–1990: Statistics Canada, *Road Motor Vehicles — Fuel Sales*, Catalogue No. 53-218, various issues.

Auto gasoline share and fuel efficiency — U.S.: 1936–1985: Federal Highway Administration, *Highway Statistics, Summary to 1985*, p. 9 and pp. 229–32. 1986–1990: FHWA, *Highway Statistics*, 1987–1990 editions, Tables MF–21A and VM–1.

Vehicle registrations — Canada: 1930–1975: Statistics Canada, *Historical Statistics of Canada*, 2nd ed., ed. F. H. Leacy (Ottawa: Supply and Services Canada, 1983), Series T147–T150. 1976–1990: Statistics Canada, *Road Motor Vehicle — Registrations*, Catalogue No. 53-219, various issue years.

Population — Canada: 1930–1990: Statistics Canada, *Canadian Economic Observer, Historical Statistical Supplement 1990/1991*, Catalogue No. 11-210, July 1991, pp. 96–97.

Occupancy rate: Royal Commission staff estimates.

3. In the absence of extended Canadian historical data series on average fuel economy for passenger automobiles, it is also assumed that average fuel economy in Canada varied in line with fuel economy in the United States. Data were available from 1936 to 1990 for the United States; the 1936 value was assumed to apply from 1930 to 1935.

In deriving an estimate of the change over time in intercity vehicle-kilometres, it would be desirable also to allow for any change in the intercity share of total car travel. There are no directly relevant data for Canada or the United States. U.S. data, however, show an approximately constant share for vehicle-miles on interstate highways and main rural roads relative to total automobile vehicle-miles. The estimate makes no allowance for any possible change in the share of intercity driving in total car travel.

4. Column 4 is the product of columns 1 and 2, divided by column 3, and indexed to 1990. It shows automobile vehicle-kilometres over this period.

5. and 6.
There is also little direct information on average occupancy, but there is reason to believe that the average occupancy rate has fallen as car ownership has become more widespread. Canadian data do exist on the ratio of car passengers to car drivers killed in car accidents for the period 1942 to the present. This ratio has

declined fairly steadily since 1942, suggesting that the average occupancy ratio has also declined. While the ratio of car occupant fatalities to car driver fatalities is not necessarily a good indicator of the average level of car occupancy, it seems reasonable to assume that, over time, these two series would tend to move in step. The automobile passenger-kilometre estimates assume that, over the historical period, the occupancy rate maintained a constant proportionate relation to the ratio of total passenger and driver fatalities to driver fatalities. A simple statistical relation between the occupancy rate from car fatalities and the ratio of population to registered automobiles was estimated for the period from 1942 to 1990. Together with information on the ratio of population to registered automobiles for the full historical period (column 5), this was used to create an occupancy index (column 6) for the full historical period.

7. Multiplying the index of vehicle-kilometres (column 4) by the index of occupancy rates provides an overall index of automobile passenger-kilometres. Given the further assumption of no change in the ratio of intercity automobile travel to total automobile travel, this is also an index of intercity passenger-kilometres. Column 7 shows this overall index with 1990 = 100 as the base value.

The overall index in column 7 is used to extrapolate backwards from the estimated level of intercity automobile travel for 1990 (Annex 1) to produce the very rough historical estimates of intercity automobile passenger-kilometres in Table 2(2)-5. A parallel approach is used to extrapolate backwards from the 1990 estimate of intercity passenger travel in light trucks. Again, U.S. data are used to provide indexes of changes in the share of gasoline consumed by light trucks, and of changes in light-truck fuel economy. A number of additional adjustments were made to the published U.S. historical series to produce the estimate for light trucks shown in Table 2(2)-5.

2.1.2 Bus

Intercity bus passenger-kilometres were extrapolated backwards from 1990 using the series shown in Table 2(2)-4.

Table 2(2)-4
SERIES USED TO EXTRAPOLATE BACKWARDS THE 1990 ESTIMATE OF INTERCITY BUS PASSENGER-KILOMETRES

Year	(1) Bus-km (millions)	(2) Average bus capacity (seats)	(3) Index of bus pass-km (1990=100)
1930			8.1
1932			6.9
1934			7.5
1936			10.3
1938			9.4
1940			16.9
1942	82.4	24.6	31.7
1944	84.3	24.9	32.8
1946	136.9	26.9	57.6
1948	173.3	29.1	78.9
1950	168.2	29.4	77.3
1952	165.7	30.3	78.4
1954	150.4	31.2	73.2
1956	142.7	32.7	72.9
1958	130.2	34.3	69.7
1960	137.9	34.9	75.2
1962	142.6	36.3	80.9
1964	148.0	36.8	85.0
1966	170.3	38.1	101.4
1968	177.7	38.7	107.4
1970	173.3	39.3	106.3
1972	172.7	39.5	106.7
1974	172.1	39.8	107.1
1976	181.4	40.1	113.7
1978	189.7	40.4	119.7
1980	201.5	40.7	128.1
1982	196.0	41.0	125.4
1984	180.3	41.3	116.2
1986	172.2	41.6	111.8
1988	156.8	41.9	102.5
1990	152.4	42.0	100.0

Sources: *Bus-km and capacity to 1970:* 1941–1955: Dominion Bureau of Statistics, *Motor Carriers — Freight — Passenger,* Catalogue No. 53-D-20. 1956–1970: Statistics Canada, *Passenger Bus Statistics,* Catalogue No. 53-215. 1974–1989: Statistics Canada, *Passenger Bus and Urban Transit Statistics,* Catalogue No. 53-215.

Notes: Index for 1930–1940 based on linkage to statistics compiled by Gordon D. Campbell, "An Analysis of Highway Finance and Road User Imposts in Canada," (Ph.D. thesis, Purdue University, 1956), Table 32, p. 258.

A constant load factor of 50% of average capacity was assumed throughout the period.

1. Published data on vehicle-kilometres by buses operated by the intercity bus industry were available for the period 1941 to 1990. Data are available for bus operators with annual revenues in excess of $20,000 for years up to 1970 and for bus operators with annual revenues in excess of $100,000 for 1974 and later years.

   These two series were used without adjustment, in spite of the reduction in coverage at the time of the shift from $20,000 to $100,000 and in spite of the tendency to relative underestimation for the earlier years in each series. Due to inflation, the exclusion of operators with revenues under $20,000 or $100,000 presumably involves the exclusion of relatively more, and relatively larger, operators in the early years of the series than in the later years. As data were not published for 1972, the figure for that year is the average of the 1970 and 1974 values.

   No allowance is made for any possible change in the relative importance of scheduled intercity bus service provided by school and charter bus operators not classified in the intercity bus industry. As indicated in Section 1 of these Notes to Chapter 2, in 1990 such operators were estimated to provide 7% of total intercity bus passenger-kilometres.

2. The size of the average bus has tended to become larger over the historical period. Column 2 shows a rough estimate of the average size of intercity buses in use. This was derived from information on the number of buses by number of seats, which is available for certain years over the period.

3. The index of changes in the amount of bus travel (column 3) is the product of columns 1 and 2, with 1990 = 100 as the base. It is assumed that average occupancy as a percent of seating capacity has remained constant over the period (50%).

For the years from 1930 to 1940, for which there are no published data on intercity bus vehicle-kilometres, the index has been extrapolated backwards from 1941 on the basis of estimates of intercity bus passenger-kilometres in a study by Gordon Campbell.[3]

The resulting index for 1930 to 1990 is applied to the 1990 estimate of intercity bus passenger-kilometres (Table 2(2)-1) to produce the rough historical estimate of intercity bus passenger-kilometres in Table 2(2)-5.

2.1.3 Air

Published passenger-kilometre data are available for domestic scheduled air services for the years 1936 to 1990. These data were adjusted by adding an estimate of passenger-kilometres on domestic charter services to produce the series in Table 2(2)-5. Estimated passenger-kilometres on domestic charter services were equal to 8%, on average, of total domestic passenger-kilometres from 1964 to 1990.

Published data on total passenger-kilometres provided by Canadian air carriers are available for 1930 to 1935; the domestic portion was assumed to be equal to 85% for this period based on the portion in the immediately following years.

2.1.4 Rail

Published data exist on total rail passenger-kilometres back to 1910. Unpublished data from Statistics Canada on passenger-kilometres on commuter services from 1970 onwards were used to produce estimates of intercity rail passenger-kilometres. The commuter share pre-1970 was assumed to equal the 9% average share of the early 1970s.

2.2 SUMMARY TABLES ON INTERCITY PASSENGER TRAVEL

The estimates of passenger-kilometres of domestic intercity travel by the different means of intercity passenger transportation, derived as discussed earlier, are presented in Table 2(2)-5. The next three tables present the same information in alternative forms to facilitate various types of analysis. Table 2(2)-6 shows the average annual growth rates for the series by decade and for certain longer intervals. Table 2(2)-7 expresses the estimates as percentage shares of total domestic

intercity travel; these percentage shares are also displayed in Chart 2-5 of Chapter 2, Volume 1. Table 2(2)-8 presents the estimates in terms of passenger-kilometres of travel per capita. This per capita table is intended to provide an impression of changes in amount of travel abstracting from overall growth in population. The per capita figures — that is, the estimates of total amounts of domestic intercity travel in Table 2(2)-5 divided by total population — obviously are not estimates of total annual travel or the change in total annual travel, by the average **user** of the mode in question. Only a fraction of the population uses any given mode and this fraction has almost certainly changed substantially over the historical period considered, although there are few direct data on this point. The fraction of the population using the air mode in a year will have risen very substantially. The fraction using cars for intercity travel probably rose somewhat, especially over the first three or four decades of the period; the fraction using intercity rail has almost certainly declined substantially since World War II; and the fraction using intercity bus may well have declined since the 1950s.

Given the very rough nature of the estimates of intercity travel by car and bus, the tables only serve to provide a general sense of the trends in intercity travel over time. They do, however, provide an adequate basis for the following general observations:

- Car travel already accounted for a large share of intercity travel by the 1930s. The absolute amount of car travel, and even more so its share of total travel, fell during World War II. Presumably this was primarily a result of the rationing of gasoline and the fact that the government used rail and bus for very large movements of military personnel. Car rapidly returned to a dominant position after the war, and its share appears to have been relatively stable since — possibly increasing modestly into the 1960s and then declining modestly over the last two decades as air travel has increased dramatically.

Table 2(2)-5

DOMESTIC INTERCITY TRAVEL IN CANADA, 1930–1990
(BILLIONS OF PASSENGER-KILOMETRES)

Year	"Car" Total	"Car" Auto.	Light trucks/ vans	Sched./ charter air	Intercity rail	Intercity bus	Total intercity travel
1930	10.2	9.7	0.5	0.007	3.3	0.4	13.9
1932	10.1	9.6	0.5	0.004	2.0	0.3	12.4
1934	10.5	10.0	0.5	0.009	2.1	0.3	13.0
1936	11.7	11.1	0.6	0.012	2.4	0.5	14.5
1938	13.7	13.0	0.7	0.014	2.4	0.4	16.5
1940	15.0	14.2	0.8	0.059	3.0	0.8	18.8
1942	12.6	11.9	0.7	0.104	6.8	1.1	20.6
1944	11.2	10.4	0.8	0.2	9.4	1.1	21.9
1946	20.8	19.6	1.2	0.3	6.4	2.0	29.3
1948	22.5	21.1	1.5	0.4	4.8	2.7	30.4
1950	26.7	24.9	1.9	0.6	3.8	2.6	33.8
1952	32.1	29.9	2.2	0.9	4.3	2.7	40.0
1954	37.5	34.9	2.6	1.2	3.9	2.5	45.1
1956	44.9	41.8	3.0	1.6	4.0	2.5	52.9
1958	49.8	46.6	3.2	2.0	3.4	2.4	57.5
1960	54.7	51.1	3.6	2.7	3.1	2.6	63.0
1962	59.0	55.2	3.9	3.4	2.8	2.8	68.0
1964	65.7	60.8	5.0	3.7	3.7	2.9	76.0
1966	77.4	72.8	4.6	5.1	3.5	3.4	89.5
1968	84.2	79.1	5.1	6.5	3.5	3.7	97.8
1970	90.1	84.1	6.0	8.8	3.1	3.6	105.7
1972	98.3	90.9	7.5	9.9	2.8	3.6	114.6
1974	107.6	98.1	9.5	13.9	2.5	3.6	127.6
1976	110.8	99.7	11.2	14.5	2.4	3.9	131.6
1978	116.3	102.9	13.4	16.3	2.5	4.1	139.2
1980	127.5	111.9	15.7	21.0	2.7	4.4	155.5
1982	118.5	103.9	14.6	18.9	2.1	4.3	143.8
1984	117.1	101.2	15.8	19.4	2.3	4.0	142.8
1986	119.2	102.7	16.4	21.9	2.2	3.8	147.0
1988	131.6	113.0	18.6	24.6	2.3	3.5	162.0
1990	135.0	115.9	19.1	25.0	1.4	3.4	164.8

Sources: *Car and light truck:* Index of automobile passenger-kilometres (Table 2(2)-3) applied to 1990 level from Annex 1. Similar approach for light trucks. See subsection 2.1.1 of text.

Air: 1930: *Canada Year Book 1931*, p. 698. 1931–1935: *Canada Year Book 1936*, p. 702. 1936–1945: M. C. Urquhart and K. Buckley, *Historical Statistics of Canada*, 1st ed. (Toronto: Macmillan, 1965), p. 551, Series 241. 1946–1975: Statistics Canada, *Historical Statistics of Canada*, 2nd ed., ed. F. H. Leacy (Ottawa: Supply and Services Canada, 1983), series T200. 1976–1987: Statistics Canada, *Air Carrier Operations in Canada*, Catalogue No. 51-002, October–December issues. 1988–1990: Statistics Canada, *Canadian Civil Aviation*, Catalogue No. 51-206, Table 2.3, and text.

Total rail passenger-kilometres: 1930–1945: M. C. Urquhart and K. Buckley, *Historical Statistics of Canada,* 1st ed. (Toronto: Macmillan, 1965), p. 535, Series 118. 1946–1975: Statistics Canada, *Historical Statistics of Canada,* 2nd ed., ed. F. H. Leacy (Ottawa: Supply and Services Canada, 1983), series T45. 1976–1987: Statistics Canada, *Rail in Canada 1987,* Catalogue No. 52-216, November 1989, p. 32. 1988–1990: Statistics Canada, *Rail in Canada 1990,* Catalogue No. 52-216, July 1992, Figure 1.6.

Intercity rail passenger-kilometres: 1970–1981: Statistics Canada, *Railway Transport: Part IV, Operating and Traffic Statistics,* Catalogue No. 52-210, Table 1. 1982–1990: Unpublished data from Transportation Division, Statistics Canada, and text.

Bus: See Table 2(2)-4 and text.

Note: Due to rounding, components may not total exactly.

Table 2(2)-6
AVERAGE ANNUAL GROWTH RATES PER DECADE AND FOR LONGER PERIODS — DOMESTIC INTERCITY TRAVEL IN CANADA, 1930–1990
(PERCENT PER ANNUM)

| | "Car" | | | Sched./ charter air | Intercity rail | Intercity bus | Total intercity travel |
	Auto.	Light trucks/ vans	"Car" subtotal				
1930–1940	3.9	4.9	3.9	23.1	−1.1	7.6	3.1
1940–1950	5.8	8.9	6.0	26.4	2.6	13.0	6.1
1950–1960	7.5	6.7	7.4	15.9	−2.2	−0.3	6.4
1960–1970	5.1	5.4	5.1	12.6	0.0	3.5	5.3
1970–1980	2.9	10.0	3.5	9.0	−1.4	1.9	3.9
1980–1990	0.4	2.0	0.6	1.8	−6.3	−2.4	0.6
1930–1960	5.7	6.8	5.8	21.7	−0.2	6.6	5.2
1960–1990	2.8	5.7	3.1	7.7	−2.6	1.0	3.3
1930–1990	4.2	6.3	4.4	14.5	−1.4	3.8	4.2

Source: Table 2(2)-5.

Table 2(2)-7
DOMESTIC INTERCITY TRAVEL IN CANADA, 1930-1990
(PERCENTAGE SHARES OF TOTAL PASSENGER-KILOMETRES)

	"Car"			Sched./ charter air (%)	Intercity rail (%)	Intercity bus (%)	Total intercity travel (%)
	Auto. (%)	Light trucks/ vans (%)	"Car" subtotal (%)				
1930	69.9	3.6	73.4	0.05	23.8	2.7	100.0
1932	77.5	4.0	81.6	0.03	15.8	2.5	100.0
1934	77.1	4.1	81.2	0.07	16.1	2.6	100.0
1936	76.3	4.1	80.4	0.08	16.3	3.3	100.0
1938	78.3	4.3	82.6	0.08	14.7	2.6	100.0
1940	75.5	4.3	79.7	0.3	15.8	4.1	100.0
1942	57.8	3.5	61.2	0.5	33.0	5.2	100.0
1944	47.7	3.5	51.2	0.7	43.0	5.1	100.0
1946	66.8	3.9	70.8	0.9	21.7	6.7	100.0
1948	69.4	4.8	74.2	1.4	15.6	8.8	100.0
1950	73.5	5.6	79.0	1.8	11.4	7.8	100.0
1952	74.8	5.6	80.3	2.2	10.8	6.7	100.0
1954	77.5	5.7	83.2	2.6	8.7	5.5	100.0
1956	79.1	5.7	84.8	3.0	7.5	4.7	100.0
1958	81.0	5.5	86.5	3.5	5.9	4.1	100.0
1960	81.1	5.7	86.7	4.3	4.9	4.1	100.0
1962	81.2	5.7	86.9	5.0	4.1	4.0	100.0
1964	80.0	6.5	86.5	4.8	4.8	3.8	100.0
1966	81.4	5.1	86.5	5.7	4.0	3.9	100.0
1968	80.8	5.2	86.1	6.6	3.6	3.7	100.0
1970	79.5	5.7	85.3	8.4	2.9	3.4	100.0
1972	79.3	6.5	85.8	8.6	2.4	3.2	100.0
1974	76.9	7.5	84.3	10.9	1.9	2.9	100.0
1976	75.7	8.5	84.2	11.0	1.8	2.9	100.0
1978	74.0	9.6	83.6	11.7	1.8	2.9	100.0
1980	71.9	10.1	82.0	13.5	1.7	2.8	100.0
1982	72.3	10.1	82.4	13.2	1.5	3.0	100.0
1984	70.9	11.1	82.0	13.6	1.6	2.8	100.0
1986	69.9	11.2	81.0	14.9	1.5	2.6	100.0
1988	69.8	11.5	81.2	15.2	1.4	2.2	100.0
1990	70.3	11.6	81.9	15.2	0.8	2.1	100.0

Source: Table 2(2)-5.

Table 2(2)-8
Domestic Intercity Travel per Capita in Canada, 1930–1990
(passenger-kilometres per person)

	"Car"			Sched./ charter air	Intercity rail	Intercity bus	Total intercity travel	Popu-lation ('000s)
	Auto.	Light trucks/ vans	"Car" subtotal					
1930	952	48	1,000	0.7	324	37	1,362	10,208
1932	914	47	961	0.4	187	30	1,178	10,510
1934	932	49	981	0.8	195	32	1,209	10,741
1936	1,010	54	1,064	1.1	215	43	1,324	10,950
1938	1,162	64	1,226	1.2	219	39	1,484	11,152
1940	1,246	70	1,316	5	261	68	1,651	11,381
1942	1,023	61	1,085	9	585	92	1,771	11,654
1944	873	63	936	13	786	93	1,830	11,946
1946	1,596	94	1,690	21	517	159	2,387	12,292
1948	1,644	114	1,758	33	371	209	2,370	12,823
1950	1,813	137	1,949	45	281	192	2,467	13,712
1952	2,068	154	2,221	62	298	184	2,765	14,459
1954	2,286	168	2,454	76	256	163	2,949	15,287
1956	2,601	189	2,790	97	247	154	3,288	16,081
1958	2,728	186	2,914	117	199	139	3,369	17,080
1960	2,859	201	3,060	151	173	143	3,527	17,870
1962	2,968	208	3,177	184	148	148	3,657	18,583
1964	3,151	257	3,407	190	190	150	3,937	19,291
1966	3,637	229	3,866	254	177	172	4,469	20,015
1968	3,819	248	4,067	313	169	176	4,725	20,701
1970	3,948	284	4,232	415	146	170	4,963	21,297
1972	4,167	342	4,509	454	127	166	5,256	21,802
1974	4,386	426	4,812	621	111	163	5,706	22,364
1976	4,334	486	4,820	632	102	168	5,722	22,993
1978	4,377	571	4,947	693	105	173	5,918	23,517
1980	4,653	652	5,305	872	112	181	6,470	24,043
1982	4,228	594	4,822	770	86	174	5,851	24,583
1984	4,052	634	4,686	778	94	158	5,716	24,978
1986	4,052	648	4,700	862	88	150	5,800	25,353
1988	4,363	717	5,080	951	87	135	6,252	25,909
1990	4,357	718	5,075	940	53	128	6,195	26,603

Source: Table 2(2)-5.

- Rail was the dominant intercity public carrier in the 1930s, although it was almost certainly much less important than private use of car even then. During World War II, rail's share may have approached the share of the car, but by the 1950s rail's share was almost certainly below its share in the 1930s, and by the 1960s air had overtaken rail as the public carrier with the largest share of domestic passenger-kilometres. Rail's share fell below that of intercity bus by the 1970s, and has continued to decline with a further sharp drop in 1990 reflecting the reductions in VIA Rail routes. The level of rail passenger-kilometres has shown a declining trend throughout the post-war period.

- Domestic intercity travel by air has grown in a manner typical of a successful new technology (or series of new technologies). It showed high growth rates from a very small base in the early decades and growth rates only moderately higher than the growth of intercity travel as a whole in the most recent period.

- Abstracting from the bulge in domestic intercity bus travel during the special conditions of World War II, the bus share in domestic intercity travel appears to have increased substantially from the 1930s to around 1950. The share has subsequently displayed a downward trend, although the rate of decline has been more gradual than for the rail share. For the 1950s through the 1970s, the decline in the bus share reflected slower growth in travel by intercity bus than in total intercity travel, rather than an absolute decline in the amount of bus travel. During the 1980s, however, there was a decline in total bus passenger-kilometres.

- The total and per capita amounts of domestic intercity travel, taking all modes together, have increased very substantially over the last 60 years — more than quadrupling in per capita terms according to the estimates used here. The increase in per capita travel, however, appears to have slowed markedly in recent years.

2.3 EARLIER ESTIMATE OF HISTORICAL TRENDS IN INTERCITY PASSENGER-KILOMETRE SHARES

A set of reasonably comprehensive estimates of intercity modal shares is contained in *Canadian Transportation Economics* by A. W. Currie, published in 1967. These estimates apparently apply to a definition of intercity travel that is similar to that which underlies the estimates presented in these Notes. Little detail on methodology or data sources is provided. Table 2(2)-9 compares Currie's estimates of intercity modal shares with those in Table 2(2)-7.

Table 2(2)-9
COMPARISON OF ESTIMATES OF HISTORICAL MODAL SHARES IN DOMESTIC INTERCITY TRAVEL
(PASSENGER-KILOMETRES)

	Currie	Table 2(2)-7	Currie	Table 2(2)-7	Currie	Table 2(2)-7	Currie	Table 2(2)-7
Year	1928	1930	1951	1952	1957	1958	1964	1964
Car	60	73	72	80	83	86	85	86
Airplane	—	—	3	2	4	4	5	5
Bus	2	3	11	7	5	4	5	4
Train	38	24	15	11	8	6	5	5

Sources: **A.W. Currie,** *Canadian Transportation Economics* **(Toronto: University of Toronto Press, 1967), p. 299 and Table 2(2)-7.**

The two sets of estimates show broadly similar trends, although Currie does estimate a smaller share for car and a higher share for rail, with the differences relative to the estimates developed here diminishing from the 1930s through the 1960s. Given the lack of information on Currie's assumptions, it is not possible to identify the source of the differences. It is possible that the assumption used here, that the intercity share in total car travel was approximately constant over the period at the 1990 level, results in an upward bias in the estimates of the car share for the earlier part of the period. This assumption does receive some support from the fact that U.S. data show little change in the ratio of car travel on highways to total car travel over the historical period considered. It is quite possible, however, especially given the rather rudimentary state of the intercity

highway network in much of Canada prior to the 1950s, that use of cars for intercity travel, as a fraction of total car travel, in fact increased over the first three decades of the period covered by our historical estimates. If so, the share of car travel in the estimates in this section is somewhat high for those decades and especially at the beginning of the period.

3. International Comparisons of Modal Shares in Passenger Transportation

Chart 2-6 and Table 2-2 in Chapter 2 of Volume 1 present approximate comparisons of the shares of car, bus, train and airplane in total domestic travel by these means for Canada, the United States, Japan, France, West Germany, Italy and the United Kingdom for selected years from 1965 to 1988. The comparative material is used to draw general conclusions as to the prevalence of the dominant role of the car, of the decline in the share of train, and of the rise in the share of air travel in countries whose geography is such that airplanes are attractive as a means of domestic travel.

The footnotes to Table 2-2 warn the reader that the data presented may not be fully comparable across the countries, and thus that small differences in the shares of a mode between two countries may reflect differences in definitions or in data estimation procedures rather than genuine differences in travel patterns. Further, while for purposes of this Royal Commission it would have been preferable to compare shares in domestic intercity travel, reasonably comparable data are only available for total domestic travel, which is the total of urban commuting, other short urban and rural trips, and intercity travel. Thus, the table and chart deal with total domestic travel by these modes. The chief difficulty in measuring domestic intercity travel is to identify the intercity portion of car travel; there is also a grey area in the definition and measurement of urban or rural travel versus intercity travel by bus and train. In Sections 1 and 2 of these Notes to Chapter 2, the rough assumption is made that intercity car

travel amounts to two thirds of total car travel on provincial highways. It was judged, however, that there was not sufficient information to make even a rough assumption for the non-North American countries.

This section first sets out the data sources and, where necessary, the assumptions used in developing the estimates. It then briefly discusses the overall results and provides some supplementary information.

3.1 THE ESTIMATES

3.1.1 Canada

Car

The estimates for car (passenger automobiles plus light trucks used for passenger transportation purposes) are based on the estimate for 1990 of total passenger-kilometres of travel by car in Annex 1, Table 2(2)-A1. This estimate is extrapolated backwards using the index of total intercity travel in Table 2(2)-3.

That index was constructed for use as an index of total car travel; it was used earlier as an index of intercity travel by car, given the assumption that the intercity share of total car travel has been constant over time.

Urban and Intercity Bus

An estimate of urban bus travel was added to the estimate of passenger-kilometres of intercity bus travel (Table 2(2)-5). Data on vehicle-kilometres of travel by urban buses are available in Statistics Canada's *Urban Transit*, Catalogue No. 53-216, for 1965 and 1970, and *Passenger Bus and Urban Transit Statistics*, Catalogue No. 53-215, for the later years.

For urban buses, an average occupancy rate of 25% was assumed — approximately the same average occupancy rate as is implicit in the U.S. estimates of urban bus passenger-kilometres. Allowing for

some increase in the size of an average bus, this implied an average number of passengers per urban bus of 10.5 in 1965, rising to 12 by 1988.

Note that urban rail transit — subways, light rail systems — have been excluded because of difficulties in obtaining data on rail transit systems for some countries. Obviously, for purposes of comparing total travel, it would be preferable to include this means of transportation. The concluding discussion will refer to supplementary data for certain countries.

Intercity and Commuter Rail

This series includes all train travel for intercity and commuter purposes; it thus includes the separate commuter train systems in Toronto and Montreal. The data for 1965 through 1975 are from Statistics Canada, *Historical Statistics of Canada*, 2nd edition, edited by F. H. Leacy, Supply and Services Canada, Ottawa, 1983, series T45, and for the later years are from Statistics Canada, *Rail in Canada*, 1987, Catalogue No. 52-216.

Domestic Scheduled Air

To enhance international comparability, the data on domestic air in Canada and the other countries are taken from a common source — the International Civil Aviation Organization (ICAO). For 1965 and 1970, they are available in the United Nations *Statistical Yearbook*, 1970, and for the later years are available in ICAO, *Civil Aviation Statistics of the World*, using the latest editions in which data for the year in question are shown. The ICAO data for Canada are slightly lower than the series shown in Table 2(2)-5, because the ICAO does not include data on small airlines.

3.1.2 United States

Car

Estimates of total vehicle-kilometres of travel by passenger automobiles and light trucks in the United States are made by the U.S. Federal Highways Administration (FHWA), and published in U.S. Department of Transportation, FHWA, *Highway Statistics* (for 1988), and *Summary to 1985* (for 1985 and earlier years). Average occupancy rates for passenger automobiles of 2.1 for 1965, 2.0 for 1970, 1.9 for 1975, 1.8 for 1980, 1.7 for 1985, and 1.5 for 1988 have been used. (Estimates from U.S. Nationwide Personal Transportation Study in U.S. Department of Transportation, *National Transportation Statistics*, July 1990.) For light trucks, occupancy of 1.3 was assumed for all years.

Bus

Estimates of intercity bus passenger-kilometres are available for all the years of interest (ENO Foundation, *Transportation in America*, 8th edition, 1990). Estimates of urban bus passenger-kilometres are available for 1980 and later years (U.S. Department of Transportation, *National Transportation Statistics, 1988*, for 1988; and American Public Transit Association, *Transit Fact Book*, 1988 edition, for 1980 and 1985). Urban bus passenger-kilometres were extrapolated to earlier years using data on number of passengers (APTA, *Transit Fact Book*).

Intercity and Commuter Rail

Estimates of rail passenger-kilometres were taken from the ENO Foundation's *Transportation in America*, 8th edition, 1990.

Air

ICAO data, sources as for Canada.

3.1.3 Japan

Car

Japanese official statistics contain estimates of car travel based on a sample survey of vehicle users. The data for 1965 through 1980 were taken from *Historical Statistics of Japan*, 1987, Vol. 2, Chapter 8, and for later years from the *Japan Statistical Yearbook*, 1991, Chapter 8.

Bus

Data on passenger-kilometres are published in the same sources used for car; they are derived from a Ministry of Transport survey of bus operators.

Rail

Passenger-kilometres of travel are measured directly and published in the same sources as the car data.

Air

ICAO data, sources as for Canada.

3.1.4 France, West Germany, Italy and the United Kingdom

Car

Data on passenger-kilometres of travel within the country's territory by vehicles registered in the country are published in European Conference of Ministers of Transport, *Statistical Trends in Transport 1965–1988*, Paris, 1992, page 51. The definition of "car" is believed to be similar to that for Canada and the United States, that is, to include passenger automobiles, vans and light trucks used for passenger transportation.

Bus

Same source as for cars (page 52). The average occupancy rates for bus differ sharply among the European countries, ranging from 11 in the United Kingdom to 20 in France. Given the lack of good data on bus occupancy and on bus passenger-kilometres, in most countries, it may be appropriate to treat these passenger-kilometre estimates with some caution.

Rail

Same source as for cars (page 31). The data refer to all traffic (both residents and non-residents) on the national rail networks of the countries in question. Independent urban railways, and some other small railways, are not included.

Air

ICAO data, sources as for Canada.

3.2 SUMMARY TABLES AND GENERAL OBSERVATIONS

Estimates of passenger-kilometres for the different means of transportation are shown in Table 2(2)-10. Table 2(2)-11 shows these same data expressed as modal shares for each country (this table is included as Table 2-2 in Volume 1, and was the basis for Chart 2-6). Table 2(2)-12 shows the data in per capita terms. Overall generalizations regarding the dominant role of the car, the declining role of rail, and the increasing role of air have already been noted. Certain further points may be mentioned, some of which also draw on supplementary data available for some of the countries.

Car

In terms of per capita travel by car, by air, and in total, Canada occupies an intermediate position between the United States, and western Europe and Japan.

Table 2(2)-10
DOMESTIC PASSENGER-KILOMETRES TRAVELLED BY EACH MODE, SELECTED COUNTRIES, 1965–1988
(BILLIONS OF PASSENGER-KILOMETRES)

Year	1965	1970	1975	1980	1985	1988
1. Car (autos, light trucks, and vans)						
Canada	198.2	253.9	300.9	337.9	310.7	341.3
United States	2,619.1	3,208.5	3,581.5	3,828.8	4,229.3	4,600.6
Japan	54.6	211.6	264.5	328.3	398.0	556.0
France	198.0	304.7	374.8	452.5	494.4	554.3
West Germany	262.5	349.6	403.3	466.5	475.8	550.5
Italy	81.2	211.9	279.3	324.0	373.7	465.4
United Kingdom	199.0	263.0	294.0	361.0	402.7	471.3
2. Urban and intercity bus						
Canada	6.2	7.2	8.4	10.4	10.5	10.5
United States	74.2	71.8	72.3	80.1	74.1	73.2
Japan	83.9	100.8	98.7	108.8	102.0	109.0
France	25.3	25.2	28.9	38.0	37.0	43.2
West Germany	39.4	48.6	58.7	65.6	54.0	53.2
Italy	28.6	32.5	42.8	58.2	66.7	77.2
United Kingdom	59.0	53.0	55.0	45.0	42.0	41.0
3. Intercity and commuter rail						
Canada	4.3	3.7	2.9	3.3	3.0	3.2
United States	28.3	17.5	16.3	17.7	18.2	20.3
Japan	258.7	290.0	319.6	316.2	334.7	368.8
France	38.3	41.0	50.7	54.7	62.1	63.3
West Germany	39.7	38.5	38.6	40.5	42.7	41.0
Italy	26.5	32.5	36.3	39.6	37.4	43.3
United Kingdom	30.1	30.4	30.3	30.3	29.7	34.3
4. Air (domestic scheduled services)						
Canada	4.2	8.0	13.9	19.9	18.7	22.2
United States	93.6	171.8	218.6	326.4	424.3	521.3
Japan	3.6	8.4	18.0	29.0	32.8	39.5
France	0.8	2.6	6.0	8.2	11.3	15.8
West Germany	0.4	1.1	1.6	2.1	2.4	2.8
Italy	0.6	1.4	2.2	2.9	4.7	5.3
United Kingdom	1.8	2.1	2.1	2.7	3.4	4.4
5. Total						
Canada	212.9	272.8	326.1	371.5	342.9	378.7
United States	2,815.3	3,469.7	3,888.6	4,253.1	4,745.9	5,215.4
Japan	400.9	610.9	700.7	782.2	867.6	1,073.3
France	262.4	373.5	460.4	553.3	604.8	676.6
West Germany	341.9	437.8	502.1	574.7	574.9	647.5
Italy	136.9	278.3	360.6	424.7	482.5	591.3
United Kingdom	289.9	348.5	381.4	439.0	477.8	551.0

Royal Commission staff calculations based on data from Statistics Canada, the European Conference of Ministers of Transport (ECMT), and a number of U.S. and Japanese sources; see text.

Table 2(2)-11
MODAL SHARES OF TOTAL DOMESTIC PASSENGER TRAVEL IN PASSENGER-KILOMETRES, SELECTED COUNTRIES, 1965-1988
(PERCENT)

Year	1965	1970	1975	1980	1985	1988
1. Car (autos, light trucks, and vans)						
Canada	93	93	92	91	91	90
United States	93	92	92	90	89	88
Japan	14	35	38	42	46	52
France	75	82	81	82	82	82
West Germany	77	80	80	81	83	85
Italy	59	76	77	76	77	79
United Kingdom	69	75	77	82	84	86
2. Intercity bus and urban transit						
Canada	3	3	3	3	3	3
United States	3	2	2	2	2	1
Japan	21	17	14	14	12	10
France	10	7	6	7	6	6
West Germany	12	11	12	11	9	8
Italy	21	12	12	14	14	13
United Kingdom	20	15	14	10	9	7
3. Intercity and commuter rail						
Canada	2	1	1	1	1	1
United States	1	1	**	**	**	**
Japan	65	47	46	40	39	34
France	15	11	11	10	10	9
West Germany	12	9	8	7	7	6
Italy	19	12	10	9	8	7
United Kingdom	10	9	8	7	6	6
4. Air (domestic scheduled services)						
Canada	2	3	4	5	5	6
United States	3	5	6	8	9	10
Japan	1	1	3	4	4	4
France	**	1	1	1	2	2
West Germany	**	**	**	**	**	**
Italy	**	1	1	1	1	1
United Kingdom	1	1	1	1	1	1

Source: Table 2(2)-10.

**   indicates a share of less than 0.5%.

Table 2(2)-12
DOMESTIC TRAVEL BY MODE, PER CAPITA, 1965–1988
(THOUSANDS OF PASSENGER-KILOMETRES PER CAPITA)

Year	1965	1970	1975	1980	1985	1988
1. Car (autos, light trucks, and vans)						
Canada	10.1	11.9	13.3	14.1	12.3	13.2
United States	13.5	15.6	16.6	16.8	17.7	18.8
Japan	0.6	2.0	2.4	2.8	3.3	4.5
France	4.1	6.0	7.1	8.4	9.0	9.9
West Germany	4.5	5.8	6.5	7.6	7.8	9.0
Italy	1.6	3.9	5.0	5.7	6.5	8.1
United Kingdom	3.7	4.7	5.3	6.4	7.1	8.3
2. Urban and intercity bus						
Canada	0.32	0.34	0.37	0.43	0.42	0.40
United States	0.38	0.35	0.33	0.35	0.31	0.30
Japan	0.85	0.97	0.88	0.93	0.84	0.89
France	0.52	0.50	0.55	0.71	0.67	0.77
West Germany	0.67	0.80	0.95	1.07	0.88	0.87
Italy	0.55	0.60	0.77	1.03	1.17	1.34
United Kingdom	1.09	0.96	0.98	0.80	0.74	0.72
3. Intercity and commuter rail						
Canada	0.22	0.17	0.13	0.14	0.12	0.12
United States	0.15	0.09	0.08	0.08	0.08	0.08
Japan	2.63	2.80	2.85	2.70	2.77	3.00
France	0.79	0.81	0.96	1.01	1.13	1.13
West Germany	0.68	0.63	0.62	0.66	0.70	0.67
Italy	0.51	0.60	0.65	0.70	0.65	0.75
United Kingdom	0.56	0.55	0.54	0.54	0.52	0.60
4. Air (domestic scheduled services)						
Canada	0.21	0.38	0.61	0.83	0.74	0.86
United States	0.48	0.84	1.01	1.43	1.78	2.13
Japan	0.04	0.08	0.16	0.25	0.27	0.32
France	0.02	0.05	0.11	0.15	0.21	0.28
West Germany	0.01	0.02	0.03	0.03	0.04	0.05
Italy	0.01	0.03	0.04	0.05	0.08	0.09
United Kingdom	0.03	0.04	0.04	0.05	0.06	0.08
5. Total						
Canada	10.8	12.8	14.4	15.4	13.6	14.6
United States	14.5	16.9	18.0	18.7	19.9	21.3
Japan	4.1	5.9	6.3	6.7	7.2	8.7
France	5.4	7.4	8.7	10.3	11.0	12.1
West Germany	5.8	7.2	8.1	9.3	9.4	10.5
Italy	2.6	5.2	6.5	7.5	8.4	10.3
United Kingdom	5.3	6.3	6.8	7.8	8.4	9.7

Table 2(2)-12 (cont'd)

DOMESTIC TRAVEL BY MODE, PER CAPITA, 1965–1988
(THOUSANDS OF PASSENGER-KILOMETRES PER CAPITA)

Year	1965	1970	1975	1980	1985	1988
Population (thousands)						
Canada	19,644	21,297	22,697	24,043	25,165	25,909
United States	194,303	205,052	215,973	227,722	238,492	245,057
Japan	98,275	103,720	111,940	117,060	121,049	122,783
France	48,758	50,772	52,705	53,880	55,170	55,884
West Germany	58,619	60,651	61,829	61,566	61,024	61,418
Italy	51,987	53,661	55,830	56,434	57,141	57,452
United Kingdom	54,218	55,421	55,901	56,330	56,618	57,065

Source: Table 2(2)-10.

Estimated car travel per capita is substantially higher in the United States than in Canada (18,800 pass-km as compared with 13,200 pass-km, in 1988). However, per capita travel by all means in the United States exceeds per capita travel in Canada by an even larger proportional amount; thus the share of car travel in Canada is slightly higher than in the United States in recent years (90% versus 88%, in 1988). While the error range in the car figures is such that one cannot be certain that the Canadian car share really is slightly larger, it seems likely that this is the case. This is the counterpart of the fact that the U.S. domestic air travel share is clearly very much larger than in Canada.

As noted in Chapter 2, Volume 1, the car share in the western European countries is now approaching the share in North America, but the dominant position of the car is much more recent in western Europe. Japan has the smallest car share, but it is growing rapidly and surpassed rail in the 1980s.

Bus

The larger share of bus in Canada than in the United States appears to be due mainly to a larger share of urban bus travel. Intercity bus travel is estimated to account for 0.9% of total domestic travel in

Canada compared with 0.7% in the United States in 1988. (Estimated intercity bus passenger-kilometres per capita are actually slightly higher in the United States (150 pass-km) than in Canada (135 pass-km), although this difference is probably within the error margins of the estimates.) However, using similar bus occupancy assumptions for the two countries, the estimated share of urban bus passenger-kilometres in total travel for Canada is more than twice the share for the United States (1.9% versus 0.7%), and per capita urban bus passenger-kilometres are about 75% higher (270 pass-km versus 150 pass-km). There is reason to believe that Canadian urban bus average occupancy ratio may be substantially higher than U.S. occupancy.[4] If this is the case, the Canadian bus share could be one percentage point or more higher, and of course the contrast with the United States would be even more striking.

Inclusion of estimates of passenger-kilometres for subway and light rail system travel in the urban transit estimates does not change the conclusion that there is much greater use of urban transit in Canada than in the United States. Again, in the absence of official estimates of occupancy rates (or of passenger-kilometres) for Canada, occupancy rates in Canada equal to those implied in U.S. passenger-kilometre data are assumed and applied to Canadian subway and light rail vehicle-kilometre data (Statistics Canada, *Passenger Bus and Urban Transit Statistics*, Catalogue No. 53-215). This yields an estimate of 3.7 billion pass-km of subway/light rail travel for Canada, or roughly half the urban bus passenger-kilometre estimate of 7 billion in 1988. In the United States, subway and light rail passenger-kilometres of 18.9 billion are also equal to roughly half the 36 billion U.S. urban bus passenger-kilometres.

In the United Kingdom, subway and light rail passenger-kilometres are estimated to equal 16% of total bus passenger-kilometres, or 1.2% of total domestic passenger-kilometres (U.K. Department of Transport, *Transport Statistics Great Britain 1979–1989*, London, HMSO, 1990). If this figure is typical of the other western European countries, it suggests that exclusion of subway and light rail urban transit from the tables, while a significant omission in terms of

covering the role of urban public transit, does not result in any very significant distortion of the estimated share of the car in total domestic travel.

Train

While train travel has decreased substantially as a share of total travel in all the countries considered, there are also major differences in its role among the countries. Whether considered in terms of share, or in passenger-kilometres per capita, train is clearly much more important in Japan than in the other countries. It is somewhat more important in France than in West Germany, Italy or the United Kingdom. In turn, train travel is several times as important in these west European countries as in Canada and, in 1988, was 50% higher — in passenger-kilometres per capita — in Canada than in the United States. Commuter rail accounts for somewhat more than half of the U.S. rail passenger-kilometres in these estimates (45 pass-km compared with 37 pass-km for intercity rail in 1988). In 1988, commuter rail passenger-kilometres in Canada were 22 per capita, while after the VIA Rail cuts intercity rail in Canada is estimated to be 52 passenger-kilometres per capita.

Air

The differences among countries in air travel's share of total domestic travel appear to reflect, most importantly, differences in geography — with air travel having higher shares in the less compact countries. Including international air travel provides a useful additional perspective on the role of air. Table 2(2)-13 repeats, for 1988, the estimates of domestic scheduled air passenger-kilometres in total and in per capita terms, and the domestic modal shares from Tables 2(2)-10 to 2(2)-12. It also shows ICAO data on international air travel, both scheduled and non-scheduled ("charter"), and the sum of domestic and international air travel. The international air travel passenger-kilometres are added to total domestic passenger-kilometres for all modes to produce an "alternative" measure of total travel. Finally, modal shares are shown using the same passenger-kilometre estimates as in the earlier tables for car, bus and train, the sum of

domestic and international travel for air, and expressing the modal figures as percentages of the alternative measure of total travel (including air).

Table 2(2)-13

IMPACT OF INCLUDING INTERNATIONAL AIR TRAVEL WITH DOMESTIC TRAVEL, 1988

	Canada	U.S.	Japan	France	Germany	Italy	U.K.
Air travel (billions of passenger-kilometres)							
Domestic scheduled (Table 2(2)-11)	22.2	521.3	39.5	15.8	2.8	5.3	4.4
International scheduled	24.0	153.3	44.6	32.0	31.3	13.9	78.6
International non-scheduled	8.1	8.1	0.3	0.2	0.1	0.8	34.5
Total air travel	**54.4**	**682.7**	**84.4**	**48.0**	**34.2**	**19.9**	**117.6**
Total domestic travel (Table 2(2)-11)	378.2	5,215.4	1,073.3	676.6	647.5	591.3	551.0
Alternative total travel[a]	410.4	5,376.8	1,118.2	708.8	678.8	605.9	664.2
Air travel per capita (thousands of pass-km per person)							
Domestic scheduled (Table 2(2)-11)	0.86	2.13	0.32	0.28	0.05	0.09	0.08
International scheduled	0.93	0.63	0.36	0.57	0.51	0.24	1.38
International non-scheduled	0.31	0.03	0.00	0.00	0.00	0.01	0.61
Total air travel	**2.10**	**2.79**	**0.69**	**0.86**	**0.56**	**0.35**	**2.06**
Total domestic travel (Table 2(2)-11)	14.6	21.3	8.7	12.1	10.5	10.3	9.7
Alternative total travel[a]	15.8	21.9	9.1	12.7	11.1	10.5	11.6
Shares of Total Travel (percent)							
Excluding international air (Table 2(2)-11)							
Car	90	88	52	82	85	79	86
Bus	3	1	10	6	8	13	7
Rail	1	**	34	9	6	7	6
Air	6	10	4	2	**	1	1
Including international air							
Car	83	86	50	78	81	77	71
Bus	3	1	10	6	8	13	6
Rail	1	**	33	9	6	7	5
Air	13	13	8	7	5	3	18

Sources: Tables 2(2)-10 to 2(2)-12 and ICAO data.

** indicates a share of less than 0.5%.

a. domestic for all modes plus international air.

The international air travel data are not for travel by residents of the countries in question, but rather are for international travel provided by carriers that are resident in the country in question. These data only provide a reasonable approximation of international air travel by residents of the country if international air travel services provided to residents by foreign carriers approximately equal international air travel services provided to non-residents by carriers of the country. For most of the countries shown, net exports or imports of passenger air services are believed to be relatively small compared with total international air travel by residents. It may be the case, however, that net exports of air services result in the figure for the United Kingdom giving a somewhat exaggerated impression of international air travel by U.K. residents, and that net imports of air services result in the figure for Italy being an underestimate of international air travel by residents of Italy. Nevertheless, for the countries shown, the estimates of international air travel provided by carriers of the country give an approximate impression of international air travel by residents of the country.

The United States has, by a substantial margin, the highest levels of domestic air travel in terms of passenger-kilometres per capita and in terms of percentage share of total domestic travel. But in per capita terms it has a lower level of international air travel than the United Kingdom or Canada, and a similar level to France and West Germany. The United States has the highest level of total air travel per capita, but Canada and the United Kingdom are not too far behind.

Inclusion of international air travel in total travel of course reduces the shares of all the other modes. Whereas, when only domestic travel was considered (Table 2(2)-11), car travel was estimated to account for a slightly larger share of total travel in Canada than in the United States; car accounts for a somewhat smaller share of total travel in Canada than in the United States if international air travel is included in the total.

4. Importance of Long and Short Trips in Domestic Intercity Travel

Chart 2-2 in Chapter 2, Volume 1, shows the number of trips in Canada in 1990 by categories of one-way distance from 80–159 kilometres to over 1,600 kilometres, as reported in the Canadian Travel Survey (CTS). Chapter 2 mentions that, in 1990, 76% of intercity trips taken were between 80 and 320 kilometres in one-way distance, but also notes that trips over 320 kilometres in one-way distance accounted for more than 60% of intercity passenger-kilometres travelled.

This brief note provides estimates that compare the shares in number of trips, and in passenger-kilometres, for trips in the different length categories (Table 2(2)-14). Both the shares of trips, and the shares of passenger-kilometres, are based on Canadian Travel Survey data for 1990. Calculation of the shares of passenger-kilometres requires use of unpublished data from the survey on average trip length in the different length categories. Estimates of both types of share are of course subject to the limitations of the CTS data discussed in Section 1 of these notes; in particular it is quite possible that recall problems by respondents result in some relative underestimation of shorter trips.

The total number of trips, and total passenger-kilometres of travel, are consistent with the numbers reported in the "CTS-based" esti-mates in Table 2(2)-1, allowing for the fact that Table 2(2)-1 counts one-way trips while Table 2(2)-14 (and Chart 2-2) count round trips, and for the fact that Table 2(2)-1 excludes trips by means other than car, air, bus, rail and ferries.

Longer trips of course account for a much larger share of total passenger-kilometres than of numbers of trips. In particular, trips over 800 kilometres in one-way distance account for 39.2% of passenger-kilometres but only 6.3% of total trips, and trips over 1,600 kilometres in one-way distance account for 26.5% of passenger-kilometres of intercity travel but only 2.6% of the number of trips.

Table 2(2)-14
DOMESTIC INTERCITY TRAVEL BY LENGTH OF TRIP, 1990
(SHARES IN NUMBER OF PERSON-TRIPS AND IN PASSENGER-KILOMETRES OF TRAVEL)

	Person-trips		Average round-trip distance	Passenger-kilometres	
	('000s)	(%)	(km)	(millions)	(%)
Trips — one-way distance					
80–159 km	62,278	46.5	219	13,650	16.8
160–319 km	39,587	29.6	427	16,897	20.8
320–799 km	20,420	15.3	930	18,984	23.3
800–1,599 km	4,954	3.7	2,079	10,297	12.7
1,600–3,199 km	2,192	1.6	4,299	9,424	11.6
3,200 km or more	1,401	1.0	8,656	12,127	14.9
Not stated	2,999	2.2			
Total	133,831	100.0	608	81,375	100.0

Source: Statistics Canada, *Touriscope: Domestic Travel 1990*, Catalogue No. 87-504, October 1991, p. 27, and unpublished Canadian Travel Survey data.

Note: Component percentage shares may not sum exactly to 100% due to rounding.

ENDNOTES

1. The occupancy rate is based on information from D. Ward's *Profile of the Intercity Bus Industry* (Transport Canada, May 1990), p. 5, and material provided to the Royal Commission by several large intercity bus firms. Ward judges typical occupancies to be about 18 passengers per bus in Canada, but, based on the occupancies recorded by the large firms, we judge that a somewhat higher assumption is appropriate. In our estimate, the system average number of passengers has been assumed to be 21, which is an occupancy rate of 50% or an average of 42 seats per bus.

2. Derived from Dennis Ward, "The Cruise Industry," Transport Canada, TP9163, April 1988. The estimate in this source of 157,000 passengers for 1987 is extrapolated forward at a 4% annual growth rate, and an allowance of 20,000 for inland waters cruise passengers is added.

3. Gordon D. Campbell, "An Analysis of Highway Finance and Road User Imposts in Canada," (Ph.D. thesis, Purdue University, Lafayette, Indiana, 1956).

4. Personal communication with officials of the Canadian Urban Transit Association.

ANNEX 1

CAR TRAVEL — TOTAL AND HIGHWAY

No direct data on total vehicle-kilometres or passenger-kilometres of travel by car exist, but approximate estimates of vehicle-kilometres may be derived in two ways:

- using statistics on sales of gasoline for road use coupled with estimates of average fuel consumption per kilometre; or

- using statistics on the total stock of passenger motor vehicles coupled with estimates of average annual distance travelled per vehicle.

Using both approaches, this Annex first develops estimates of vehicle-kilometres of travel for both "passenger automobiles" and for "light trucks" (four-wheel vehicles, other than passenger automobiles, under 4,500 kg in laden weight, such as, pickups, minivans and 4-wheel drive vehicles) used for passenger transport. Separate data on the amount of travel on provincial highways by these classes of vehicle are then considered. Finally, assumptions as to the number of occupants per vehicle are introduced in order to arrive at rough estimates of the number of passenger-kilometres of travel by car in total and on highways.

A1.1 TOTAL TRAVEL — VEHICLE-KILOMETRES

Gasoline Sales Plus Fuel Economy

Sales of gasoline taxed for use in road motor vehicles totalled 31.8 billion litres in 1990 (Statistics Canada, *Road Motor Vehicles — Fuel Sales, 1990*, Catalogue No. 53-218). Unpublished National Energy Board studies for the mid-1980s suggest that 65% of sales are for passenger automobiles, with the remainder being consumed in other vehicles, such as light trucks, non-diesel heavier trucks and buses, and motorcycles. Fragmentary evidence suggests that about 80% of this remaining 35% of sales, or 8.9 billion litres, is for light trucks.

Statistics Canada's *Fuel Consumption Survey*, Catalogue No. 53-226, which was last conducted for 1988, provides what are believed to be quite reliable estimates of average fuel economy for passenger auto-mobiles and light trucks for the period covered by the survey. These estimates are 12.0 litres per 100 kilometres for passenger automobiles in 1988, and 16.6 litres per 100 km for light trucks in 1987. While there may have been some improvement in average fuel economy since 1988, these estimates are used. Applied to the gasoline sales estimates, they suggest total travel in 1990 of 172.5 billion vehicle-kilometres for passenger automobiles, and 55 billion vehicle-kilometres for light trucks.

Stock of Cars Plus Average Annual Use

Personal-use passenger automobiles sampled by the Fuel Consump-tion Survey were driven an average of 17,400 kilometres in 1988, while light trucks were driven an average of 18,200 kilometres. The stock of vehicles to which these average distances should be applied is less than the figures appearing in Statistics Canada's *Road Motor Vehicles — Registrations* (Catalogue No. 53-219). During sampling for the fuel consumption surveys it was found, for 1983, that about 8% of registered passenger automobiles had been scrapped, 2% of registrations were duplications, and another 10% were in existence and operable but out of service in dealers' hands, in storage or under repair.[1] Passenger automobile registrations for 1990 were 12.6 million. Applying the estimate of average annual kilometres driven (17,400 for passenger automobiles) to 80% of the registrations level (or 10.1 million vehicles) suggests 175.6 billion vehicle-kilometres of travel by passenger automobiles in 1990, compared with the esti-mate of 172.5 billion vehicle-kilometres derived using gasoline sales. A rounded estimate of 175 billion vehicle-kilometres of travel for 1990 is used.

Motor vehicle registration figures are believed to include most light trucks, as defined earlier, in the "trucks" sub-category of "commercial

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1.   E. Lawrence, *Fuel Consumption Data Book,* Technical Memorandum TMSE 9102, Transport Canada, March 1991, pp. 111–15.

vehicles." There were 3.9 million "trucks" registered in 1990, of which 500,000 are estimated to be heavy trucks,[2] suggesting 3,400,000 light trucks. Assuming that, as for passenger automobiles, the number of light trucks in use is only about 80% of the number of light truck registrations, suggests that the 18,200 average annual kilometres of use figures should be applied to about 2,700,000 light trucks in use, yielding an estimate of 49 billion vehicle-kilometres. This compares with the estimate of 55 billion vehicle-kilometres derived using fuel sales data. A rounded estimate of 50 billion vehicle-kilometres for 1990 is used. Further, it is assumed that 80% of this amount, or 40 billion vehicle-kilometres, were for private passenger transport, with the remainder for freight use.

A1.2 HIGHWAY TRAVEL — VEHICLE-KILOMETRES

The estimates are based on the study for the Royal Commission by Nix, Boucher and Hutchinson in Volume 4 of this Report, which uses provincial highway traffic count data. With the modification discussed in Notes to Chapter 3, subsection 5.1.1 of this Volume, it is estimated that travel on provincial highways by passenger automobiles was about 97.5 billion vehicle-kilometres in 1990 and 100 billion vehicle-kilometres in 1991. Travel by light trucks in use for passenger transportation purposes is estimated to be 19 billion vehicle-kilometres in 1990 and 20 billion in 1991.

A1.3 PASSENGER-KILOMETRES OF TRAVEL

There is very little information on the average number of occupants per passenger automobile or light truck overall or in different types of use. Estimates for the United States from the Nationwide Personal Transportation Survey (NPTS) indicate an overall occupancy rate of 1.5 for 1990, with average occupancy ranging from 1.1 for work trips, through 1.5 for shopping trips, 1.7 for other family/personal trips, to 1.8 for social/recreational trips. Canadian vehicle ownership per

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2. See Appendix A of Fred P. Nix, Michel Boucher and Bruce Hutchinson, "Road Costs," in Volume 4 of this Report.

capita or per household is somewhat lower than in the United States, and it is reasonable to assume that average occupancy is somewhat higher. Average occupancies for passenger automobiles of 1.8 persons in highway driving, and 1.5 persons in other (primarily urban) driving, are assumed. For light trucks, given the predominance of pickup trucks with fewer seats than cars, average highway occupancy of 1.5 persons and average other occupancy of 1.2 are assumed.

These occupancy assumptions, when combined with the vehicle-kilometre estimates, yield the estimates of passenger-kilometres of highway and total travel in 1990 shown in Table 2(2)-A1.

Table 2(2)-A1
ESTIMATES OF VEHICLE- AND PASSENGER-KILOMETRES: CAR, 1990

	Veh-km (billion)	Pass-km (billion)
Passenger automobile		
Highway	97.5	176
Other	77.5	116
Total	175	292
Light truck in passenger transportation use		
Highway	19	29
Other	21	25
Total	40	54
Both ("car")		
Highway	116.5	205
Other	98.5	141
Total	215	346

These estimates are used as the basis for a number of other estimates in Sections 1, 2 and 3 of the Notes to Chapter 2. In Section 1, two thirds of the highway total of 205 billion passenger-kilometres, or a rounded 135 billion passenger-kilometres, is used as a rough estimate of intercity car travel. In Chapter 3 of Volume 1, 210 billion passenger-kilometres is shown as the estimate of total passenger-kilometres of car highway travel for 1991. In Section 3, the 346 billion estimate of total car travel for 1990 (rounded to 350 billion) is used in calculating the 1988 Canadian figure for the international comparison of total travel by the different means of transportation.

NOTES TO CHAPTER 3: COSTING METHODOLOGY AND DERIVATION OF COST ESTIMATES

INTRODUCTION

Chapter 3 presents estimates of Canadian (average and total) domestic intercity passenger modal costs and average modal costs for four illustrative routes. Chapter 18 includes projections of system total and illustrative route-specific average costs to the year 2000.

These modal estimates encompass:

- infrastructure;

- environmental costs;

- accident costs;

- transportation taxes and fees; and

- vehicle and carrier operations.

The cost estimates are split into the portion of the cost paid by the users or travellers and the portion of average cost paid by the taxpayer, by other travellers on other routes and by society in other than financial terms, for example, through suffering the effects of pollution.

1. UNDERSTANDING THE TABLES

The tables in Volume 1, Chapters 3 and 18 are intended to portray the costs of domestic passenger transportation in Canada including environmental and accident "costs," currently borne by the public, and the cost and financial implications, to users and taxpayers, of the Royal Commission's recommendations. Table 3(2)-1 reproduces the illustrative system-average costs from Table 3-1 of Volume 1.

To help the reader understand what the estimates in Table 3(2)-1 cover, Table 3(2)-2 provides a hypothetical expansion of the portion of a table showing results for a particular means of travel. This table could illustrate average costs per passenger-kilometre, total costs in

millions of dollars, or current and projected costs per trip on a specific route. It could apply to the 1991 cost estimates of Volume 1, Chapter 3 or it could apply to the scenario projections of Volume 1, Chapter 18. The numbers used have no significance; they are intended purely to help explain the meaning of the table components.

Table 3(2)-1
ILLUSTRATIVE SYSTEM-WIDE AVERAGE ANNUAL COSTS OF INTERCITY DOMESTIC TRAVEL
(CENTS PER PASSENGER-KILOMETRE)

Type of cost	Car			Bus		
	Users	Others	Total	Users	Others	Total
Infrastructure	0.0	2.1	2.1	0.0	0.3	0.3
Environmental	0.0	0.6	0.6	0.0	0.2	0.2
Accident	3.7	0.1	3.8	0.4	0.0	0.4
Special trans. tax/fee	1.2	−1.2	0.0	0.3	−0.3	0.0
Vehicle/Carrier	10.9	0.0	10.9	8.4	0.2	8.6
Total	15.8	1.6	17.4	9.1	0.4	9.5

Type of cost	Airplane			Train		
	Users	Others	Total	Users	Others	Total
Infrastructure	2.2	3.4	5.6	2.9	0.0	2.9
Environmental	0.0	1.0	1.0	0.0	0.6	0.6
Accident	0.1	0.0	0.1	0.2	0.0	0.2
Special trans. tax/fee	0.6	−0.6	0.0	0.4	−0.4	0.0
Vehicle/Carrier	14.4	0.0	14.4	7.4	32.8	40.2
Total	17.3	3.8	21.1	10.9	33.0	43.9

Type of cost	Ferry			All intercity travel		
	Users	Others	Total	Users	Others	Total
Infrastructure	0.0	4.7	4.7	0.2	2.2	2.4
Environmental	0.0	2.0	2.0	0.0	0.6	0.6
Accident	0.1	0.0	0.1	3.3	0.1	3.4
Special trans. tax/fee	0.9	−0.9	0.0	1.1	−1.1	0.0
Vehicle/Carrier	24.1	11.6	35.7	11.2	0.2	11.4
Total	25.1	17.4	42.5	15.8	2.0	17.8

Note: In order to illustrate smaller components, averages are shown to the nearest tenth of a cent. In general, cost estimates are approximate and are not accurate to this level of precision. See text.

Table 3(2)-2
COST TABLES ILLUSTRATION: HYPOTHETICAL EXAMPLE
(DOLLARS)

Type of Cost	Users	Travellers	Federal	Provincial	Public	Total costs
			Costs borne by:			
		Others				
			Government			
Infrastructure						
Links	25		−6			19
Terminals	15		3			18
Control			2			2
Environmental					24	24
Accident	4			1		5
Special trans. tax/fee						
Fuel taxes	16		−9	−7		0
Licence fees	1		−1			0
Vehicle/Carrier	333	−35		3		301
Total	394	−35	−11	−3	24	369

The key element of the sample expansion is the column "others," which identifies four categories of cost sustainers and funds providers or recipients: travellers, federal government, provincial government and the public. Also, the infrastructure row is subdivided in this example into links, terminals and control; and the special transportation tax/fee row, into fuel taxes and licence fees. Of course, other categories might apply.

Starting with infrastructure, in terms of airplane travel, the $25 shown for links in the users column could indicate a traveller payment of Air Transportation Tax. This exceeds, by $6, the $19 total cost of air navigation support paid by the federal government as shown in the total column. Thus, the $6 is shown as negative, being a net revenue gain to the federal government. For terminals, $15 in landing fees represents an under-recovery of airport costs by $3. In the column others/government/federal, the traffic control cost of $2 is shown as not recovered, by a specifically designated payment.

In the environmental row, a cost to the public of $24 is shown. This represents a valuation estimate of the physical effects of environmental damage experienced by members of the public. At present, no transactions related to these costs occur.

The treatment of accident costs is more interesting analytically. The traveller, through her or his fare via the carrier's insurance cost, is shown as paying $4 and the provincial government pays $1, in medicare. Were this means of travel a road vehicle, the accident cost imposed on the occupants of other vehicles and not fully compensated by the travellers and their insurance would be included under users. This is based on the view that incurring the risk of such costs is part of the "price" paid when one travels by road. An alternative approach would be to separate out accident costs to other travellers and include them as a further "others" sub-category.

Special transportation taxes and fees, from the point of view of others, are government revenues, and are represented by negative costs of $9 in fuel taxes and $1 in licence fees paid by the traveller to the federal government (actually paid by the carrier from the traveller's fare). The $7 under provincial fuel taxes, a negative cost to provincial governments, represents the traveller's share of this tax; this is an estimate of the amount that exceeds the provincial sales tax that applies generally.

The vehicle/carrier cost of $333 under users may be viewed as the balance (on average) of what a traveller pays toward his or her total fare that is attributable to cost items other than those represented in the rows above it in the matrix.

Viewing the other elements of the vehicle/carrier row, travellers are shown as receiving a $35 "cross subsidy,"[1] and the provincial government is shown as paying a subsidy of $3, presumably direct, toward vehicle/carrier costs.

The total row indicates that travellers pay an average fare of $394. Because the average total cost of the hypothetical trip is $369, the average traveller appears to pay $25 more than the costs concerned — if one does not subtract the $35 cross subsidy to other travellers. Although the federal and provincial governments have net financial gains of $11 and $3 respectively, this does not balance a $24 cost to the public for environmental damage.

As mentioned, Table 3(2)-1 and the tables of Chapters 3 and 18 use a more condensed format in which the "others" columns, the "infrastructure" and "special transportation tax/fee" rows are not subdivided. The expanded, illustrative table shows the possible components of a single entry in the condensed format.

2. COSTING BASIS

Among the modes, the consistency of costing basis was limited by the structure of the data available for each mode. With the exception of the car, and with it vans and light trucks, costing and cost estimates were confined to public unit toll travel. Private airplane and boat transportation were not included. Chartered aircraft (true charters where the aircraft is leased generally with crew, fuel and supplies — not low priced travel, with tickets, that may be advertised as charter), bus and boat travel were also excluded where the data allowed.

In the case of bus, this was an important exclusion. It is estimated that 2.6 billion bus passenger-kilometres[2] were on domestic-origin, non-urban, non-school chartered service. This compares with the estimated 3.3 billion passenger-kilometres for scheduled domestic intercity bus services, which are the subject of the cost and other bus references of Volume 1.

Where possible, the costs presented are for domestic origin and destination travel. In some cases the domestic portion of international trips have been included; for the automobile, rail and bus, all travel within Canada was included. For air, international flights that

originate or terminate in Canada and overflights of Canadian airspace were excluded; however, it was not possible to exclude domestic flights (separate ticket coupon) that were part of what was essentially an international trip.

3. COSTING PRINCIPLES

In general, the analysis is intended to produce an estimate of long-run average costs for the industry. Thus, all costs, including those of head office, were attributed to services they presumably support. Unless there was evidence that joint costs were attributable to less than the total product mix, these costs (for example, for VIA Rail stations) were allocated or attributed to services primarily on the basis of volume of use.

The ways in which density, speed, stage or journey length affected costs were considered and incorporated in developing cost estimates for types of routes.

An opportunity-cost-of-capital rate of 10% real (10% plus inflation) was used for all operators and modes. This figure is recommended for use throughout the federal government[3] as a social discount rate, and, when adjusted for inflation, is very close to the cost-of-capital rate for CP as calculated by the National Transportation Agency.

Wherever practical, capital costs of equipment and infrastructure (depreciation and cost of capital) were treated on a current value basis.[4] For most equipment and infrastructure this amounted to replacement value costing. Essentially, depreciation and the 10% real cost of capital, applied to the replacement cost of the remaining capital investment, were taken as representative of the full opportunity cost of invested capital. Also included as a capital charge was the opportunity cost of capital invested in the land occupied by road, track, airport and port infrastructure wherever the magnitude of this cost was believed to be substantial — primarily airport property.

Applying a common rate of capital cost to estimates of the replacement value of the capital stock in use helps make cost estimates for the different modes comparable. In particular, these cost estimates are not affected by differences in the extent to which a given entity is debt financed or may have received what might be viewed as equity capital at no charge from governments.

4. DATA AND COST DEVELOPMENT

The system average or typical cost estimates that follow were developed from the data available, with gaps filled on the basis of engineering costing, essentially aggregating the costs of the inputs, and on quoted ticket prices.

Statistics Canada publications were the primary sources of data for the system-wide costs. For costing purposes, Statistics Canada provided special aggregations of data. Data were also obtained from provincial authorities; Transport Canada; the Transportation Association of Canada; Canadian air, bus, ferry and railway carriers; and published studies. The key source of data for the carrier costs on the illustrative routes provided in Volume 1 was the industry. The response of the airline, railway, ferry and bus companies to requests for detailed cost, revenue, traffic and market data was most gratifying. In some cases, however, data were provided on a confidential basis. Respecting this confidentiality limits the specificity or extent of detail that can be reported for some of the cost estimates.

Most of the costs were estimated for 1989 or the organizations' fiscal year 1989–90, but some 1990 and 1991 data were used, and in some cases it was necessary to use pre-1989 data. The estimates were adjusted approximately to 1991 cost and price levels.

Costs were intended to represent normal 1991 conditions, but many of the input data were, as has been noted, from other recent years. Where there were reasonable grounds to suggest changes that had occurred to 1991, such changes were incorporated, and all estimates were converted to 1991 prices.

The illustrative 1991 costs used are not an estimate of actual 1991 levels; 1991 was an unusual year with some major carriers suffering large losses. The 1991 year carried surprises and anomalies that are not expected to persist. An attempt was made to represent the longer-term trend. All costs are in 1991 prices, but essentially represent a "normal" recent year.

The system-average costs by mode in Chapter 3 were estimated in cents per passenger-kilometre (¢/pass-km). The estimates of total costs by mode for 1991 were obtained by multiplying these system-average costs by the Royal Commission's estimates of total passenger-kilometres in that year.

5. INFRASTRUCTURE COSTS

5.1 CAR

5.1.1 Costs of Highway Construction and Maintenance

Estimates are based on the report to the Royal Commission by Nix, Boucher and Hutchinson,[5] in Volume 4 of this report. The study estimates the total costs for deterioration and maintenance of the provincial paved highway system, based on estimates published by the Transportation Association of Canada as well as Canadian models of highway-lifecycle costs. The study's estimates, by necessity, are very approximate. This is due primarily to uncertainty in the causes and attribution of road wear, but also in part to uncertainty in the spending estimates. The absence in Canada of data on highway traffic by vehicle weights and axle configurations particularly contributes to these uncertainties.

An important unresolved technical question is the extent of interaction between pavement deterioration due to climate and deterioration due to wear. The report effectively assumes there is no such interaction, as do these notes.

It is possible that deterioration identified by Nix et al. as being sepa-
rately caused by climatic conditions is in fact the joint result of climate
and traffic, and that the traffic contribution is therefore underesti-
mated. Research to date has not adequately explored this relationship,
and it remains an important issue for research into the design of a
correct cost attribution and pricing regime.

The tentative allocation of costs to vehicle classes in the Nix et al.
report provides the basis for the estimates of infrastructure costs in
Table 3(2)-1, but with two important modifications:

- Nix et al. allocated all common costs (including those parts of
  pavement deterioration dependent on climate rather than wear,
  common annual maintenance items, and administrative costs)
  according to vehicle-kilometres by vehicle class. Royal Commission
  staff calculations have instead allocated these costs according to
  vehicle-kilometres weighted by "passenger-car-equivalent" units
  (PCEs), with an average heavy truck representing 2.5 PCEs, and an
  average bus, 2 PCEs.

- The report estimated total traffic wear on the provincial highway
  systems as 158 billion vehicle-kilometres, about 43 billion of which
  was on the "middle 30%" of paved two-lane rural highways. This
  seems high based on the evidence presented (from counting vehicles
  using each class of highway in some provinces), and an annual
  average daily traffic (AADT) of 2,000 vehicles instead of 3,000 has
  been assumed for these highways, thereby reducing the estimate
  for this sub-network to about 28 billion vehicle-kilometres and the
  total for the provincial network to 144 billion vehicle-kilometres.

The resulting estimated costs by class of road are shown in Table 3(2)-3.
While costs per route-kilometre to build highways to higher stan-
dards are greater, such highways tend to have high traffic volumes
over which those costs are spread. Therefore, costs per passenger-
kilometre are lower on the higher quality and higher traffic density
highways.

Road class	Annual average daily traffic (number of vehicles)	Costs by vehicle type		
		Car/ light truck	Heavy truck	Bus
Expressway	12,000	0.47	2.62	1.06
Other paved highways:				
Densest 10%	6,000	0.71	3.99	1.56
Medium 30%	2,000	1.77	9.79	3.71
Least dense 60%	700	4.77	21.38	9.77
Average highway	—	1.46	5.48	3.00
Cents per pass-km	—	0.83	—	0.14
Cents per pass-km, in 1991 prices	—	0.91	—	0.15

The costs as estimated are identical for cars and light trucks. The final two rows (in ¢/pass-km) for car and light truck costs represent averages combined in proportion to their passenger-kilometres, using the standard assumptions of average occupancies of 1.8 passengers per car and 1.5 passengers per light truck, giving a combined average of 1.76. The estimates of costs per passenger-kilometre for buses assume average occupancy of 45% of 47 seats, or 21.15 passengers per bus.

5.1.2 Cost of Highway Capital

While depreciation (pavement deterioration) is included in the estimates, the cost of capital for highway infrastructure must be added. The Royal Commission staff estimates of highway cost of capital are quite speculative. Very little information is available to allow estimation of the size of the highway capital stock. A study by Lall, in Volume 4 of this report,[6] updating earlier work for the Canadian Transport Commission and Transport Canada,[7] suggests the entire road network stock amounted to about $52 billion in 1988. Updated only by inflation, this would have amounted to about $59 billion in 1991. The proportion of this that is for intercity or extra-urban highways can only be guessed.

The paved provincial highway network to which the estimates of Nix et al. apply, consists of about 140,000 two-lane kilometres, of a total of 880,000, or 16%. This relatively small proportion, however, includes all of the costly provincial expressways[8] and highways through urban areas, and all paved rural highways, which are of higher quality and cost than unpaved provincial or municipal roads or than municipal streets. For illustrative purposes, it is guessed that the paved highways are 40% to 60% of the total capital stock; that is, $24 billion to $35 billion.

The amount of these costs that is attributable to car and light truck traffic must be estimated next. The allocation by PCEs attributes 59% of common highway costs to passenger cars, and 15% to light trucks. It is assumed that about 80% of light truck use is for passenger travel, so the total proportion of highway cost for cars and light trucks in passenger use is estimated at 70%. Applying the same proportion to the capital costs, the costs attributed to cars and light trucks would amount to $16 billion to $25 billion.

Then this cost must be converted to an annual amount. The assumption throughout these cost estimates has been that the appropriate (opportunity-cost) rate with which to calculate the annual cost attributable to capital investment is 10% per year. The highway cost of capital attributed to passenger cars would therefore amount to $1.6 billion to $2.4 billion.

Finally, the cost per passenger-kilometre can be estimated by averaging the annual capital cost over total travel of 210 billion passenger-kilometres. These very rough computations suggest the value is in the range of 0.8¢/pass-km to 1.12¢ pass-km. As this is of the same order of magnitude as the earlier estimate of the highway deterioration/maintenance cost per passenger-kilometre, and relies on such rough reasoning, the capital charge is incorporated by simply doubling the deterioration/maintenance cost for each class of vehicle and type of highway.[9]

In consequence, the cost for cars of road infrastructure is estimated as 0.91 × 2 = 1.82¢/pass-km.

5.1.3 Land Costs

A difficulty in allowing for land costs is that if they are included in the accounts of transport authorities at all, they are likely to be based on historical purchase prices, which do not adequately represent current values. More particularly, they do not represent the value the land would have if liberated for other use. This is essentially an argument that the appropriate value to include is the "opportunity cost," that is, the value of the land in alternative use.

An attempt to estimate the opportunity cost of highway land is described in Annex 1 to these Notes. Using simple assumptions, it is estimated that the 137,236 route-kilometres of provincial highways in Canada in 1990 used some 475,000 hectares of land (or 1.17 million acres, about 1,800 square miles). If valued entirely as farmland, this had a value of some $580 million. If the alternative use included residential development of about 1% of the land, at an average value of $370,000 per hectare, the cost amounted in 1990 to $2.4 billion.

Converting this latter amount to an annual rate, using 10% per year as the opportunity-cost rate for capital assets, as indicated earlier, then allocating land cost among vehicle types according to PCE-km, and finally averaging the car cost over 210 billion passenger-kilometres, the resulting estimate is 0.08¢/pass-km. Given the uncertainty in this estimate, particularly in forecasting alternative use of the land, it is incorporated in the highway infrastructure costs as a rounded 0.1¢/pass-km.

5.1.4 Costs of "Control"

In addition, an amount is added for the "control" costs of infrastructure, consisting of the police enforcement costs and driver/vehicle enforcement and control programs for cars, analogous to the air traffic control and navigation systems in other modes. Some sparse

evidence suggests police traffic-control costs amounted in 1987 to about $450 million per year.[10] Vehicle and driver registration fees amount to about $64 per vehicle per year,[11] or about $850 million per year. It is guessed for illustrative purposes that these fees just balance the provincial expenses on police traffic services and the other relevant program costs — that is, that the control component of infrastructure costs amounts to about $64 per year in 1990 prices, or 0.36 cents per vehicle-kilometre (¢/veh-km) over an average 17,600 kilometres per vehicle per year. Converted to 1991 prices, and averaged over 1.76 passengers per vehicle, this amounts to 0.22¢/pass-km.

Total infrastructure costs for cars, including construction and main-tenance, land and control are finally estimated as 1.82 + 0.1 + 0.22 = 2.14¢/pass-km.

5.1.5 Car "User-Borne" Infrastructure Costs, from Road Tolls

The only significant road tolls in Canada are those for the Coquihalla Highway in British Columbia.[12] Revenues were $18.4 million in fiscal year 1988–89, $21.2 million in 1989–90,[13] and $32.9 million in 1990–91.[14]

Separate estimates of revenues from passenger cars and trucks are not available, but a rough guess is sufficient for present purposes. It can be guessed that the total from cars and privately used light trucks would have been about $20 million in 1991.

Because national highway traffic in 1991 is estimated at 210 billion passenger-kilometres, these Coquihalla tolls would have amounted to about 0.01¢/pass-km, clearly not sufficiently large to appear in the system-average car infrastructure costs per passenger-kilometre of Table 3(2)-1.

5.2 BUS

5.2.1 Highway Construction and Maintenance Costs

The highway infrastructure costs for buses are shown in Table 3(2)-3. They were obtained from the estimates of Nix et al. and modified to

allocate all common components by PCE-km with an intercity bus comprising two PCEs. The traffic estimates for bus by type of highway are even more approximate than those for cars and heavy trucks.

The costs per vehicle-kilometre in Table 3(2)-3 are divided by an average occupancy of intercity buses of about 21 passengers, obtained from an average load factor of 45% for an average 47-seat bus, from the investigation of bus carrier costs by Royal Commission staff and consultants.

The weighted average cost for all road types amounts to 0.146¢/pass-km in 1991 prices (rounded in Table 3(2)-3 to 0.15¢/pass-km).

Capital charges are added to this cost following the same reasoning as for car infrastructure costs: that it seems legitimate as a first approximation to **double** the estimated road deterioration costs to allow for charges on the remaining capital value of the road structures. The total costs therefore become $0.146 \times 2 = 0.292$¢/pass-km.

5.2.2 Land Costs

Opportunity costs of highway land attributable to buses can be estimated as for cars, allocating the total opportunity costs, estimated at $240 million per year, according to PCE-km. Intercity buses contribute only some 0.2% of total PCE-km. Their share of land costs would then be about $0.5 million per year. Averaged over total bus travel of 3.3 billion passenger-kilometres, this would amount to 0.02¢/pass-km.

Total bus infrastructure "way" costs, including land, are thus rounded to 0.3¢/pass-km. Costs of traffic control for buses are assumed to be too unimportant to change this rounded total.

5.3 COMPARISON OF COSTS AND REVENUES FOR HEAVY TRUCKS

The procedures to identify highway infrastructure costs for cars/light trucks and buses also produce estimates for "heavy trucks" (the class heavy truck refers to any truck with a gross vehicle weight

rating over 4.5 tonnes, though the maximum permitted nationally is 62.5 tonnes).[15] The report for the Royal Commission on road construction and maintenance costs provided its interpretations of the relationships between costs and truck axle configurations, axle weights and gross vehicle weights.[16] It allocated common components of costs arising from deterioration due to climate together with central costs of administration on the basis of vehicle-kilometres driven. Its methods provide an estimate of 1989 costs for the provincial highway systems for an average heavy truck of 3.82¢/veh-km, or about 4.17¢/veh-km in 1991 prices.[17]

The Royal Commission staff modifications to those estimates included allocating all common components of costs by PCE-kilometres, with an average heavy truck being 2.5 PCEs. The allocation procedure can then be reduced to the following formula, based on gross vehicle weight (GVW) and equivalent-standard-axle loads (ESALs)[18] as well as PCEs:

Cost per vehicle-kilometre in 1989 ¢
= 0.0235(GVW) + 1.5602(ESALs) + 1.037(PCEs)

The average heavy truck above consists of 23.3 tonnes GVW, with 1.5 ESALs, and 2.5 PCEs. Its costs then become 5.48¢/veh-km, or approximately 6¢/veh-km in 1991 prices. To allocate fully all highway costs, as was done earlier for passenger cars/light trucks, a cost of the invested capital should also be included. A preliminary approximation, in the absence of a confident estimate of the stock of highway capital, suggests this would be of a broadly similar order to the construction and maintenance cost, about 4¢ to 6¢/veh-km in 1991 prices.[19] The total cost for the average truck then becomes 10¢ to 12¢/veh-km.

Average truck revenues have been estimated using schedules of registration fees for trucks obtained from the provincial governments of Nova Scotia, New Brunswick, Ontario and Saskatchewan, together with a function relating truck fuel consumption to gross weight

obtained from a study of road user costs and revenues for Transport Canada.[20] The fuel tax rate is the Canadian average estimated for diesel fuel in 1991 of 13.1¢ (net of normal sales taxes).

For the average heavy truck, the registration fee is approximately $1,000 per year and the fuel tax rate approximately 6¢/veh-km. The revenue from such a truck would be less than the fully-allocated costs of 10¢ to 12¢/veh-km for a truck travelling more than about 20,000 kilometres per year; and for such a truck travelling 100,000 kilometres per year, the excess of cost over revenue would be $3,000 to $5,000.

Similar computations can be made for some typical truck configurations suggested in the report to the Royal Commission by Nix et al., as follows:

Configuration	Gross weight (tonnes)	Average cost (¢/veh-km)	Registration fee per year ($)	Average fuel tax (¢/veh-km)
Straight truck (T3)	25	11–14	1,000	6.1
Tractor-semitrailer (3-S2)	39	15–19	1,700	7.1
B-double (3-S3-S2)	62	20–26	3,000	9.6

Revenues would be substantially outweighed by costs for each of these types of trucks if they are used for more than about 20,000 kilometres per year. Using the upper bounds of the cost estimates, the cost for the 25-tonne straight truck used for 50,000 kilometres per year would outweigh revenues by about $3,200; while if the tractor-trailer and tractor-double-trailer trucks were used for 100,000 kilometres per year their costs would outweigh revenues by approximately $10,000 and $13,000 respectively.[21]

Marginal costs would, of course, be lower than the above fully allocated average costs. The research report to the Royal Commission included an initial exploration of the manner in which costs of pavement construction, reconstruction and resurfacing vary with use, which suggests that marginal costs of heavy truck use would be very much lower.[22] Once the common cost elements allocated by PCEs — such as the climate-induced deterioration and administration costs — were ignored, marginal costs would also be more than proportionally less for trucks with lower axle weights (for example, for the double-trailer truck than for the straight truck in the these examples). Similarly, once those common elements are ignored, marginal costs would be less on high-volume roads. A pricing regime designed both to be efficient and to recover the fully allocated costs would need a thorough investigation of the relationships between average and marginal costs.

5.4 AIR

Unit costs for airport and air navigation services (ANS) were developed by Sypher : Mueller International Inc.[23] from financial data for expenditures associated with airport and aviation infrastructure. Transport Canada expenditures are shown in Table 3(2)-4; related revenues (excluding the Air Transportation Tax) are also included. Some of the costs for, and revenues from, airport property are not attributable to the provision of airport services, and were excluded from the present cost analysis. Costs, as calculated here, are more comprehensive, particularly in including the economic cost of invested capital.

Airport output statistics and cost and revenue data were provided by Transport Canada on a site-by-site basis. The ANS costs were assembled at the national level and were treated as a network, while airport costs were developed on a site-by-site basis. Enroute ANS services provided for the benefit of international flights that do not land in Canada are budgeted separately by Transport Canada, and are almost exactly recovered from specific fees.

Table 3(2)-4

TRANSPORT CANADA AIR PROGRAM EXPENDITURES AND REVENUES, 1989–90

($ MILLIONS)

Expenditures	Aviation	Airports	Total
Operating	559	363	922
Capital	230	209	439
Total	**789**	**572**	**1,361**

Revenues	Aviation	Airports	Total
Enroute/Other ANS	30	—	30
Landing fees	—	128	128
General terminal	—	89	89
Airline space rental	—	50	50
Other airline revenues	—	18	18
Commercial/Industrial	—	186	186
Total	**30**	**471**	**501**

Source: Data from Transport Canada, *1989–90 Estimates: Part III, Expenditure Plan* (Ottawa: Supply and Services Canada, 1989).

5.4.1 Airport Cost Allocation

The Royal Commission developed the infrastructure cost attributable to commercial aviation at each of the 98 airport facilities in which Transport Canada has a significant interest. The 98 airports were divided into four groups for which data with varying degrees of cost detail were available.[24]

Group I — Lester B. Pearson International Airport (Toronto) and Vancouver Airport: These are the two largest airports in Canada, both in terms of facilities and operations, and are the only sites in Canada that are currently operating at, or near, capacity. As such they have certain distinct asset utilization characteristics and hence cost functions.

Group II — Remaining major federal airports (MFAs): The other six MFA sites (Calgary, Edmonton, Winnipeg, Ottawa, Montreal and Halifax) have facilities roughly the same size and all play a similar role in the national transportation system.

Group III — Sites processing or capable of annually handling 200,000 enplaned/ deplaned (E/D) passengers: These sites have a minimum level of airfield and terminal facilities that in most cases is adequate to handle volumes of up to a million passengers. The facilities and operations of airports in this group, and their cost behaviour, are generally similar.

Group IV — Remaining Transport Canada airports: These facilities are generally small and provide limited services. They have been further subdivided to segregate, in Group IVb, those airports that might be considered "outliers" because of remoteness and/or because the primary orientation may not be toward serving scheduled commercial carriers.

Groups III and IV are referred to as Federally Dependent Airports (FDAs). Fourteen of the airports in Group III used to be accounted for as MFAs; therefore, more detailed data are available for these ex-MFAs. Excluded from these airport groupings were the hundreds of community airports located across Canada. Because these airports are small, do not provide scheduled services, and only limited financial data is available for them, these sites were not included in this study. These airports, however, are an essential link to many small communities.

Direct operating costs, excluding depreciation, were gathered for each site. The cost allocation methodology and data sources and detail varied by airport group. For MFAs, total direct operating costs and operating costs by profit centre were available; this allowed easy removal of costs that were not to be attributed to users. Costs associated with state and military aircraft, as estimated by Transport Canada, were removed from site operating expenses. Also, emergency response service (ERS) costs were attributed strictly to the commercial passenger services and not to other users, such as the Department of National Defence and general aviation.

Costs associated with concession/groundside facilities and industrial areas were available from detailed costing studies that were performed in 1988–89, which allocated a portion of site costs to each of

these profit centres. For the 14 ex-MFAs, total direct operating costs and costs associated with concession/groundside facilities and industrial areas were available for 1987–88 from Transport Canada's Financial Projection System, which also allocated a portion of site costs to each of these areas or profit centres.

The direct total operating costs and industrial costs for the remaining FDAs were extracted from Transport Canada's Statement of Revenue and Expenses. Because the financial data recorded for the FDA sites were minimal, a proxy of 10% was used to remove costs associated with concession/groundside facilities. It was further assumed that the industrial profit centre was operated on a break-even basis, and as such, expenses should equal revenue generated. Data were available on industrial rentals, which then served as a proxy for the costs associated with this area.

The Transport Canada allocation of corporate overhead to operating sites was not adopted. No overhead costs were allocated to the eight MFA sites, as they may be considered self-sufficient. These sites have a full complement of management and administrative functions and do not rely on headquarters for support. Therefore, all departmental overhead costs were allocated among the directly managed sites on the basis of direct airfield and terminal operating and maintenance costs.

Airfield costs have been allocated to commercial aviation traffic and to general aviation traffic[25] (other than for-hire transportation) at each airport on the basis of aircraft weight. At congested sites such as the Toronto (Pearson) and Vancouver airports, a movement-based allocation might be argued to be superior, because each movement imposes approximately the same time demands on the facilities and services capacity. A movement-based allocation, however, would be difficult to defend for uncongested airports, since this method assumes that each movement causes the same amount of "wear and tear" on airport assets, regardless of size. A weight base also may be argued to be related to willingness to pay (and to "Ramsey" pricing[26]) and is a more widely accepted and defensible practice for fee setting.

Terminal costs have been measured in relation to the number of passengers enplaned and deplaned. Terminal costs were allocated solely to commercial aviation with the assumption that general aviation makes only minimal use of the terminal building.

Capital infrastructure was included in the cost base on a current replacement value basis (escalated historical cost).[27] As a cross check, the replacement cost based on facility size, for terminal and runway assets, and current construction costs were calculated for a number of sites.

The replacement value was then divided by the 30-year average life of assets on an airport site to determine the annual allocation of past capital investment (depreciation). For ANS assets a 20-year life was used. The opportunity cost of capital component was calculated by multiplying capital replacement value by 50% to get average depreciated value, and then by a real interest rate of 10%.

For the airport system, four basic cost groups were used:

1. Total Commercial Airfield Costs = Commercial Airfield Operations and Maintenance (O&M) Costs + Commercial Airfield Overhead Costs + Commercial Airfield Capital Costs;

2. Total Commercial Terminal Costs = Commercial Terminal O&M Costs + Commercial Terminal Overhead Costs + Commercial Terminal Capital Costs;

3. Total General Aviation (ga) Instrument Flight Rules (IFR) Costs = ga IFR Airfield O&M Costs + ga IFR Airfield Overhead Costs + ga IFR Airfield Capital Costs; and

4. Total ga visual flight rules (VFR) Costs = ga VFR Airfield O&M Costs + ga VFR Airfield Overhead Costs + ga VFR Airfield Capital Costs.

Terminal costs were allocated to the commercial users on the basis of enplaned passengers, and airfield costs at each airport were allocated to commercial users, ga IFR users, and ga VFR users on the basis of their respective weight landed.

A summary of the cost allocation procedure is shown in Table 3(2)-5. Included here are all operations expenses and revenues, net of expenses and revenues attributable to activities that take place on the airport property but do not directly relate to the services Transport Canada provides to the airline and other aviation users of the facilities. Exclusions include industrial developments on the airport property, parking, and retail and refreshment concessions.

5.4.2 Air Navigation Services Cost Allocation

Air navigation costs include the cost of air traffic control, flight service stations, and the provision of radio navigation aids. The cost of ANS was divided between local ANS costs and enroute ANS costs. Local ANS costs are the costs of services provided at each airport (for a 50 km radius) while enroute costs are the costs of services provided while an aircraft is between airports.

Operating costs for both local and enroute facilities were derived from data provided by Transport Canada. The data were available in a form that separated local from enroute services and isolated domestic and international enroute services. The international services (polar and oceanic) are near full cost recovery. Thus, both revenues and expenses were excluded from the calculations, leaving a reasonably accurate picture of the costs and revenues of domestic enroute services. These data were also available from Part III of the 1989–90 Estimates,[28] although the detail required to allocate costs to international enroute services for area control centres and flight service stations was not available. As with the airport costing exercise, these accounts represent only direct operating costs and exclude depreciation.

Overhead costs were extracted from Transport Canada's *Proposed New Cost Recovery Policy: Phase II Discussion Paper* (TP 10041). For ease of allocation, overhead comprised ANS regulation costs, ANS safety costs, ANS branch overhead, and an allocated share of Transport Canada's corporate overhead.

Table 3/2I-5
COST ALLOCATION FOR AIRPORTS, RANKED BY ENPLANED/DEPLANED PASSENGERS
(THOUSANDS OF 1991 DOLLARS UNLESS OTHERWISE STATED)

Oper- ator	Site	Prov.	1988 E/D passengers	1988–89 total operating expenses excluding deprec.	Approx. aviation oper./ overhead costs (1991)	Attrib. airfield capital cost (1991)	Attrib. terminal capital cost (1991)	Attrib. comm. aviation (airlines) cost (1991)	Revenue from comm. aviation (airlines) (1991)	Full cost per E/D pass. ($)	Deficit per E/D pass. ($)	Cost attrib. to general aviation (1991)
I.												
TC	Toronto	Ont.	20,269,180	53,833	45,310	32,917	40,231	118,412	87,192	6	2	89
TC	Vancouver	B.C.	8,840,180	20,845	15,802	13,413	20,120	49,275	38,065	6	1	109
	Subtotal		29,109,360	74,678	61,112	46,330	60,351	167,687	125,257	6	1	198
II.												
TC	Montreal	Que.	8,761,049	49,990	36,915	44,536	50,222	131,480	55,641	15	9	286
TC	Calgary	Alta.	4,549,797	13,983	10,301	8,015	20,610	38,838	24,732	9	3	147
TC	Winnipeg	Man.	2,459,932	10,883	6,347	5,505	5,964	17,737	11,498	7	3	93
TC	Edmonton Int.	Alta.	2,072,354	10,608	8,594	4,286	5,455	18,303	10,922	9	4	77
TC	Halifax	N.S.	2,338,372	10,101	8,264	4,351	3,024	15,613	8,531	7	3	83
TC	Ottawa	Ont.	2,711,415	9,495	2,763	3,573	9,660	15,931	12,667	6	1	66
	Subtotal		22,892,919	105,060	73,185	70,267	94,935	237,901	123,991	10	5	751

Oper-ator	Site	Prov.	1988 E/D passengers	1988-89 total operating expenses excluding deprec.	Approx. aviation oper./overhead costs (1991)	Attrib. airfield capital cost (1991)	Attrib. terminal capital cost (1991)	Attrib. comm. aviation (airlines) cost (1991)	Revenue from comm. aviation (airlines) (1991)	Full cost per E/D pass. ($)	Deficit per E/D pass. ($)	Cost attrib. to general aviation (1991)
III.												
TC	Victoria	B.C.	759,878	1,843	2,259	0	2,230	4,501	1,831	6	4	124
TC	Quebec	Que.	733,774	3,542	4,487	1,822	1,916	8,155	2,882	11	7	204
TC	St. John's	Nfld.	702,264	4,306	6,423	1,611	1,480	9,467	2,445	13	10	193
TC	Regina	Sask.	654,249	3,284	5,069	3,161	2,153	10,239	2,859	16	11	317
TC	Saskatoon	Sask.	642,765	2,898	4,229	1,241	897	6,293	2,794	10	5	276
TC	Thunder Bay	Ont.	591,975	2,764	4,202	1,068	1,030	6,202	2,111	10	7	374
N	Kelowna	B.C.	395,436	1,544	2,529	16	1,395	3,945	1,042	10	7	53
TC	Moncton	N.B.	293,483	2,712	3,692	724	710	5,062	992	17	14	296
TC	Windsor	Ont.	283,108	1,747	2,403	804	1,471	4,571	1,277	16	12	302
TC	Prince George	B.C.	275,340	2,132	3,259	1,537	1,877	6,578	710	24	21	247
TC	London	Ont.	255,643	2,463	3,119	1,137	1,039	5,116	941	20	16	540
TC	Saint John	N.B.	245,801	2,486	3,872	1,130	544	5,516	1,292	22	17	130
TC	Sault Ste. Marie	Ont.	245,400	1,854	2,816	17	3,308	6,147	600	25	23	135
N	Sudbury	Ont.	236,508	1,442	2,036	1,407	411	3,677	377	16	14	444
TC	Fredericton	N.B.	207,475	2,116	2,820	354	636	3,802	760	18	15	90
TC	Charlottetown	P.E.I.	205,610	2,415	3,526	693	2,573	6,768	654	33	30	115
TC	Yellowknife	N.W.T.	192,044	2,389	3,641	841	2,465	6,916	376	36	34	133

Table 3(2)-5 *(cont'd)*
COST ALLOCATION FOR AIRPORTS, RANKED BY ENPLANED/DEPLANED PASSENGERS
(THOUSANDS OF 1991 DOLLARS UNLESS OTHERWISE STATED)

Oper-ator	Site	Prov.	1988 E/D passengers	1988–89 total operating expenses excluding deprec.	Approx. aviation oper./ overhead costs (1991)	Attrib. airfield capital cost (1991)	Attrib. terminal capital cost (1991)	Attrib. comm. aviation (airlines) cost (1991)	Revenue from comm. aviation (airlines) (1991)	Full cost per E/D pass. ($)	Deficit per E/D pass. ($)	Cost attrib. to general aviation (1991)
TC	Timmins	Ont.	191,673	1,481	2,267	154	2,288	4,709	463	25	22	57
TC	Sydney	N.S.	182,456	2,382	3,889	669	889	5,441	588	30	27	62
TC	Whitehorse	Y.T.	123,659	1,928	2,644	2,891	2,295	7,300	247	59	57	907
	Subtotal		7,418,541	47,728	69,180	21,279	31,606	120,404	25,242	16	13	4,997
IVa.												
TC	Deer Lake	Nfld.	165,292	1,453	2,418	0	1,194	3,618	402	22	19	24
TC	Kamloops	B.C.	138,478	1,294	1,950	0	3,383	5,342	496	39	35	64
TC	Prince Rupert	B.C.	131,357	1,049	1,663	1,364	3,739	6,750	179	51	50	34
N	Rouyn/ Noranda	Que.	117,036	982	1,531	1,216	462	3,169	233	27	25	90
TC	Val d'Or	Que.	114,128	2,262	3,461	23	2,339	5,836	430	51	47	45
TC	Lethbridge	Alta.	110,717	1,269	1,809	194	2,247	4,220	196	38	36	190
N	Bagotville	Que.	107,245	186	68	421	237	305	10	3	3	667
TC	North Bay	Ont.	104,411	1,596	1,754	1,563	2,008	5,081	364	49	45	446
TC	Grand Prairie	Alta.	103,214	1,296	1,941	1,260	3,518	6,583	340	64	60	260
N	Hamilton	Ont.	96,909	1,038	1,085	592	537	1,985	203	20	18	606
N	Castlegar	B.C.	95,926	607	956	809	595	2,267	0	24	24	184
N	Campbell River	B.C.	93,352	546	695	25	762	1,484	170	16	14	40
N	Cranbrook	B.C.	90,452	916	1,528	0	2,526	4,061	276	45	42	37
TC	Fort McMurray	Alta.	90,094	1,109	1,557	614	6,305	8,398	261	93	90	184

Table 3(2)-5 (cont'd)

Cost Allocation for Airports, Ranked by Enplaned/Deplaned Passengers
(Thousands of 1991 dollars unless otherwise stated)

Oper-ator	Site	Prov.	1988 E/D passengers	1988–89 total operating expenses excluding deprec.	Approx. aviation oper./overhead costs (1991)	Attrib. airfield capital cost (1991)	Attrib. terminal capital cost (1991)	Attrib. comm. aviation (airlines) cost (1991)	Revenue from comm. aviation (airlines) (1991)	Full cost per E/D pass. ($)	Deficit per E/D pass. ($)	Cost attrib. to general aviation (1991)
TC	Terrace	B.C.	89,699	1,070	1,747	1,040	2,336	5,102	177	57	55	54
TC	Penticton	B.C.	84,612	1,073	1,657	0	1,025	2,691	408	32	27	97
TC	Mont Joli	Que.	79,586	1,499	2,452	1,522	2,788	6,748	301	85	81	38
TC	Stephenville	Nfld.	65,602	1,833	2,959	209	4,008	7,182	284	109	105	17
TC	Baie Comeau	Que.	58,725	946	1,321	643	802	2,702	165	46	43	163
N	Sarnia	Ont.	49,500	751	1,194	532	1,059	2,729	117	55	53	130
TC	Smithers	B.C.	47,800	587	882	1,310	1,601	3,667	195	77	73	190
TC	Williams Lake	B.C.	36,400	551	831	819	1,221	2,796	114	77	74	124
TC	Yarmouth	N.S.	34,900	1,234	1,832	582	1,171	3,548	131	102	98	117
TC	Quesnel	B.C.	30,300	498	764	387	537	1,640	89	54	51	110
N	Kenora	Ont.	26,200	444	706	358	158	1,198	82	46	43	66
N	Charlo	N.B.	24,276	1,025	1,602	608	189	2,380	197	98	90	71
	Subtotal		2,186,211	27,114	40,365	16,092	46,747	101,482	5,820	46	44	4,047
IVb.												
TC	Sept Iles	Que.	151,255	2,478	3,756	1,403	2,980	8,098	536	54	50	123
TC	Fort St. John	B.C.	137,004	1,737	2,828	0	2,992	5,828	432	43	39	49
TC	Gander	Nfld.	124,728	7,842	12,482	2,634	2,524	17,628	2,267	141	123	117
N	Thompson	Man.	109,705	706	977	1,284	637	2,832	300	26	23	112
N	Goose Bay	Nfld.	80,151	6,742	5,803	5,977	20,552	32,175	609	401	394	251
TC	Inuvik	N.W.T.	76,305	1,365	2,025	2,729	2,950	7,642	182	100	98	105
TC	Wabush	Nfld.	74,248	1,655	2,630	1,037	1,437	5,086	282	69	65	68

Table 3(2)-5 (cont'd)

COST ALLOCATION FOR AIRPORTS, RANKED BY ENPLANED/DEPLANED PASSENGERS
(THOUSANDS OF 1991 DOLLARS UNLESS OTHERWISE STATED)

Oper-ator	Site	Prov.	1988 E/D passengers	1988–89 total operating expenses excluding deprec.	Approx. aviation oper./overhead costs (1991)	Attrib. airfield capital cost (1991)	Attrib. terminal capital cost (1991)	Attrib. comm. aviation (airlines) cost (1991)	Revenue from comm. aviation (airlines) (1991)	Full cost per E/D pass. ($)	Deficit per E/D pass. ($)	Cost attrib. to general aviation (1991)
TC	Iqaluit	N.W.T.	64,852	1,564	1,377	4,410	1,182	6,932	334	107	102	46
TC	Sandspit	B.C.	40,347	853	1,205	1,029	815	3,036	189	75	71	26
TC	Iles de la Madeleine	Que.	39,959	487	810	614	218	1,640	119	41	38	8
TC	Port Hardy	B.C.	39,782	714	1,051	1,710	3,187	5,830	172	147	142	165
TC	Churchill	Man.	34,692	2,656	4,234	3,951	1,368	9,524	239	275	268	65
TC	Kuujjuaq	Que.	30,200	1,621	2,522	1,691	768	4,950	165	164	158	84
N	Red Lake	Ont.	29,800	187	107	523	708	818	111	27	24	697
TC	Norman Wells	N.W.T.	27,402	927	1,453	856	1,261	3,528	122	129	124	105
TC	Hay River	N.W.T.	26,070	806	1,274	1,696	1,276	4,216	93	162	158	51
TC	The Pas	Man.	21,863	1,029	1,567	511	411	2,464	80	113	109	87
TC	Fort Smith	N.W.T.	19,650	525	836	1,218	1,336	3,361	59	171	168	48
TC	Kapuskasing	Ont.	18,300	312	477	2,256	1,125	3,681	100	201	196	210
TC	Fort Nelson	B.C.	14,200	863	1,265	2,605	1,781	5,329	112	375	367	451
TC	St. Anthony	Nfld.	13,500	517	827	1,217	407	2,370	41	176	173	132
N	Schefferville	Que.	9,800	185	261	369	247	846	32	86	83	51
N	Wemindji	Que.	6,200	178	302	803	468	1,572	39	254	247	1
TC	Earlton	Ont.	4,500	213	287	165	142	564	24	125	120	74
N	Eastmain	Que.	4,300	188	302	470	272	1,040	17	242	238	6
TC	Abbotsford	B.C.	4,100	856	565	1,486	2,810	4,177	132	1,019	986	887
TC	Gore Bay	Ont.	500	137	145	326	274	582	8	1,163	1,147	245
TC	Muskoka	Ont.	500	167	160	107	76	287	23	573	528	159

Table 3(2)-5 (cont'd)

Cost Allocation for Airports, Ranked by Enplaned/Deplaned Passengers
(Thousands of 1991 dollars unless otherwise stated)

Oper-ator	Site	Prov.	1988 E/D passengers	1988–89 total operating expenses excluding deprec.	Approx. aviation oper./overhead costs (1991)	Attrib. airfield capital cost (1991)	Attrib. terminal capital cost (1991)	Attrib. comm. aviation (airlines) cost (1991)	Revenue from comm. aviation (airlines) (1991)	Full cost per E/D pass. ($)	Deficit per E/D pass. ($)	Cost attrib. to general aviation (1991)
N	North Battleford	Sask.	500	108	114	518	715	1,119	5	2,238	2,229	274
N	St. Leonard	N.B.	500	350	496	505	186	1,087	7	2,174	2,160	200
N	Swift Current	Sask.	500	70	76	332	685	889	7	1,778	1,764	247
TC	Wiarton	Ont.	500	186	179	421	237	608	10	1,216	1,195	364
N	Yorkton	Sask.	500	125	104	378	489	755	8	1,510	1,494	278
TC	Baker Lake	N.W.T.	0	895	1,488	1,161	305	2,947	10	#	#	16
TC	Cambridge Bay	N.W.T.	0	880	1,454	1,038	375	2,868	49	#	#	4
TC	Coral Harbour	N.W.T.	0	1,007	1,685	865	234	2,780	0	#	#	12
TC	Eureka	N.W.T.	0	22	37	64	15	116	0	#	#	1
N	Fort Resolution	N.W.T.	0	172	275	115	69	449	0	#	#	28
TC	Fort Simpson	N.W.T.	0	503	783	602	194	1,543	24	#	#	80
TC	Nanisivik	N.W.T.	0	509	857	1,063	369	2,288	8	#	#	3
N	Resolute Bay	N.W.T.	0	3,554	4,842	1,572	465	6,857	95	#	#	95
TC	Tofino	B.C.	0	46	61	2,116	559	2,523	1	#	#	219
TC	Tuktoyuktuk	N.W.T.	0	341	567	200	75	837	1	#	#	16
TC	Watson Lake	Y.T.	0	883	1,249	1,219	571	2,824	43	#	#	414
	Subtotal		1,206,413	47,161	65,794	55,246	59,747	176,526	7,087	146	140	6,673
	Total		62,813,444	301,741	309,637	209,214	293,386	804,001	287,397	13	8	16,666

Similar to airport capital assets, the value used in the cost base was replacement cost. The replacement value was determined by reviewing the current asset base and known major capital expenditures (such as the current programs of radar modernization and microwave landing systems), and estimating what it would cost to replace these navigation aids. The replacement cost for local and enroute facilities was divided by a factor of 20, which represents the average number of years in the life of ANS capital assets. A cost of capital component was calculated using an interest rate of 10%.

For ANS, as for airports, four cost groups were used:

1. Total Local Commercial and General Aviation (ga) IFR Costs = Local Commercial and ga IFR O&M + Local Commercial and ga IFR Overhead + Local Commercial and ga IFR Capital Costs;

2. Total Local Flight Service Station (FSS) Costs = Local FSS O&M + Local FSS Overhead + Local FSS Capital Costs;

3. Total Enroute Commercial and ga IFR Costs = Enroute Commercial and ga IFR O&M + Enroute Commercial and ga IFR Overhead + Enroute Commercial and ga IFR Capital Costs; and

4. Total enroute VFR Costs = Enroute VFR O&M + Enroute VFR Overhead + Enroute VFR Capital Costs.

Local air navigation services costs were therefore allocated:

	$ millions (1991)	
	Local	Enroute
Commercial	137	344
General Aviation IFR	16	15
General Aviation VFR	118	75

Local costs were allocated to users based on each user's tower arrivals and FSS arrivals. Enroute costs were allocated to users on the basis

of domestic total kilometres flown by each group. The resulting cost functions are:

Commercial = $42.54/movement + $0.15/km

ga IFR   = $41.16/movement + $0.15/km

ga VFR   = $82.69/movement + $1.01/km

Alternatively, the cost attributed to commercial aviation can be allocated on the basis of passengers and passenger-kilometres. To do this, it was first necessary to divide the total among domestic and international services. Cost attributable to overflights that do not land in Canada has already been excluded. For the balance that takeoff and/or land in Canada, to allocate the attributed $137 million local air navigation services cost, enplanements plus deplanements are estimated as:

Domestic	24 million × 2 × 1.2 stages ⟶	58 million E/D
Canadian international carriers		13 million E/D
Foreign carriers (assume)		15 million E/D
		_____
		86 million E/D

This amounts to $1.60 per passenger per takeoff or landing (1/2 stage).

Enroute costs attributable to commercial aviation of $344 million may be allocated on the basis of airplane-kilometres under Canadian enroute control, estimated from data on movements and assumptions as to controlled flight length. Itinerant movements in 1990 (Statistics Canada Catalogue No. 51-206, Table 7.1) for commercial carriers are:

	Movements	Distance
Domestic	3,387,000	800 kilometres
Trans-border	256,000	300 kilometres under Canadian control
Other international	64,000	1 000 kilometres under Canadian control

With the domestic operation accounting for 2.71 billion of a total of 2.85 billion airplane-kilometres, or a share of 95%, enroute costs attributable to commercial domestic operations are $327 million. Allocating over 25 billion domestic passenger-kilometres gives a unit cost of 1.4¢/pass-km.

5.4.3 Air Infrastructure Cost (Excluding Land Occupancy)

The final product was the set of cost functions that estimate the unit costs of airport and aviation infrastructure in Canada. By applying the commercial carrier cost model, it was possible to calculate an average cost per passenger from any origin to any destination in Canada.

To calculate the average infrastructure costs applicable to a typical trip, the airport cost function and the corresponding air navigation cost function are used. As an example, consider a trip to Saskatoon from Halifax of approximately 3 500 km, in a B-727 or A320 aircraft with 136 seats, operating at a (system-average) load factor of 0.675, via one intermediate stop (change of flights) at Toronto. The trip thus has two stages, which means two takeoffs and two landings at three airports.

The attributed commercial airlines' costs at Saskatoon, Toronto and Halifax from Table 3(2)-5 give a per passenger airport cost of:

Halifax	$ 7
Toronto (two movements)	$12
Saskatoon	$10
	———
	$29

Total navigation costs would be:

$6.40 + 3 500 km at 1.4¢ = $55[29]

Not including cost attributable to investment in land, total costs per passenger of air infrastructure services are estimated at $84. Including $20 for the opportunity cost of land in use at the airports, total infrastructure cost becomes $104 per passenger (use of unrounded intermediate data would yield $105).

5.4.4 Cost of Land Used for Airports

One can only speculate about the extent and type of development that would take place if the airports were removed from their current sites. Unique mixes of types of use are likely at each of the sites.

An attempt to estimate the opportunity costs of airport land is described in Annex 2 to these Notes. For the nine major airports, potential values as farmland, or in industrial, commercial or residential development are considered.

The areas of land occupied by these airports are very large, and in a number of cases are in locations that would be advantageous for development if the airports were abandoned (or relocated). The areas concerned, however, are so large that they would add substantially to the land available, and could probably only be sold for development at prices below those currently attained for equivalent land.

Indications of potential values of the land at these airports is provided in Table 3(2)-6, based on the following assumptions (described further in Annex 2):

- The sites at Edmonton, Mirabel and Halifax airports are valued as farmland.

- At Calgary, Winnipeg and Ottawa airports, the sites are valued at 25% of the current price for light industrial land.

- For Vancouver and Dorval airports, the available land is valued at 50% of the current price for light industrial land.

- For Toronto (Pearson) airport, the site area is valued at 50% of the current price for residential land.

Table 3(2)-6
OPPORTUNITY COSTS OF LAND AT MAJOR AIRPORTS, 1991

Airport	Estimated land values ($ millions)
Vancouver	500
Calgary	200
Edmonton	8
Winnipeg	130
Toronto (Pearson)	750
Ottawa	440
Montreal (Dorval)	400
Montreal (Mirabel)	10
Halifax	1
Total (rounded)	**2,500**

The value of those nine major airports is therefore estimated at about $2.5 billion. For the 20 next most important airports, it is assumed that the average value per hectare is half that of these nine airports, excluding Pearson and Vancouver. Their total value would be about $400 million. For all remaining airports, the value of the land is assumed to be negligible.

The total capital value estimated therefore is about $2.9 billion. At a real rate of return of 10%, the annual cost is $290 million per year. Averaged over a total of about 63 million enplaned/deplaned (E/D) passengers at all airports in 1988, the total land value would then amount to $4.60 per passenger. For the illustrative system-wide costs in 1991, this is rounded up to $5 per E/D passenger, or $10 per stage. Averaged over the representative air trip (1.6 stages) of 1 478 km, it amounts to 1.08¢/pass-km (rounded to 1¢/pass-km for system average).

5.5 RAIL

The Royal Commission's intercity railway carrier costing is described in Volume 4 of this report.[30] The cost of infrastructure services is shown but there was no cost analysis beyond acceptance of the price

VIA Rail pays the freight railways for track use. Infrastructure payments, including some station rents and incentive payments, which amount to 2.9¢/pass-km, represent only a relatively small proportion of VIA Rail's costs — about 7%. On the per passenger-kilometre basis, however, they are somewhat higher than the estimate of car infrastructure costs and much higher than the estimate of bus costs. Rail track costs are also discussed in the Notes to Chapter 6 in this volume, but without focus on the costing methodology.

The charges VIA Rail pays for track use are closer to being based on a marginal cost concept than on the fully allocated average cost concept used in costing infrastructure for all the other means of passenger transportation.

Payments by VIA Rail to the freight railway track owners for track use and other related services, such as dispatching, signals and communications, are negotiated among the parties — including the Minister of Transport's representative. Should agreement not be reached, however, the fall-back position is long-term avoidable cost as defined by regulations administered and interpreted by the National Transportation Agency. The relationship between CN and CP charges to VIA Rail, and the additional cost that the passenger operation actually imposes on the freight railways, have formed the topic of review by the Canadian Transport Commission and the National Transportation Agency (most recently, the NTA's 1988 *VIA Rail Costing Review*), and a variety of studies by, and for, interested parties including the provincial governments.

The applicable regulations (essentially, the CTC's Costing Order, R-6313) in effect interpret avoidable cost in this case as being long-run variable cost, with respect to track use, including the variable portions of maintenance expense and of capital-related costs — depreciation and cost of capital. Capital-related costs are based on depreciated original cost, historical asset lives, the cost of capital

for CP computed in nominal dollars, and an estimated relationship between track maintenance operating expenditures and gross tonnage. As already noted, this differs from the estimate of allocated total cost, with capital treated on a replacement value basis, that was used for the other modes.

It may be of interest to observe that, for rail freight, infrastructure costs generally and the cost of the capital invested in the track infrastructure are much more important relative to total costs than they are for passenger transportation. The 1989 balance sheets for CN and CP[31] show a combined "ways and structures" property investment of over $10 billion at original cost (over $8 billion of it track and roadway), with accumulated depreciation of approximately $3 billion. At a nominal cost of capital of 15% (10% real plus 5% infla-tion), $7 billion of invested capital represents an annual cost of invested capital of over $1 billion. This equals 20% of 1989 gross freight revenues.

Allocating a pro rata share of this rough estimate of an infrastructure capital charge using the industry rule of thumb — 1 pass-km = one freight tonne-km — would only suggest an $11 million allocation to passenger costs — the equivalent of 0.4¢/pass-km — in 1989. This may be viewed as an indication of the maximum understatement of passenger rail infrastructure costs relative to costs for other modes, as VIA Rail payments would, in principle, already include a capital charge related to a portion of the capital implicitly allocated to it on this pro rata basis.

5.6 FERRY

The infrastructure provided for marine ferries not included in vehicle/carrier cost estimates comprises the navigation services and regula-tory activities provided by Transport Canada. The amounts of these services provided for the ferries cannot be distinguished readily, as

the services are provided jointly for all shipping. Analyses published as part of the development of Transport Canada's cost-recovery policy do not yet provide an allocation of costs to each type of user, but do distinguish attributable costs in 1990–91 for a number of programs.[32] Programs assumed to be used (or provided) in part for ferries are the following (costs include allowances for depreciation and costs of capital):

	Total costs, 1990–91 $ millions
Vessel traffic services	17.46
Short-range navigation aids	272.98
Safety and public communication	14.53
Ship safety	32.66
Emergencies	25.05
Total	362.70

It is reasonable for illustrative purposes, and in the absence of information on the use of these services by ferries, to allocate the services among various types of commercial shipping according to ship-kilometres travelled in Canadian waters. Using Transport Canada's estimate that ferries account for 11.84%, the amount of the total cost thus attributable to ferries is $42.94 million.

This amount is then distributed between freight and passenger ferry traffic as are the other ferry cost items, according to automobile-equivalent-unit kilometres. The passenger portion is estimated as $35.4 million.

Averaging this cost over the total (non-commercial) passenger-kilometres in 1990 produces a (rounded) 4.5¢/pass-km. When inflated to 1991 dollars, this amounts to 4.7¢/pass-km, which appears in Table 3.1 of Volume 1.

6. Environmental Damage Costs

6.1 EMISSIONS OF AIR POLLUTANTS AND GREENHOUSE GASES

Derivations of costs of emissions are described in the Notes to Chapter 7 in this volume. System-wide averages estimated there (in Table 7(2)-7) are the following (in 1991 prices):

Means of Travel	Costs (¢/pass-km)
Bus	0.246
Car	0.577
Train	0.642
Airplane	0.921
Ferry	1.972

6.2 NOISE

While noise can be an important component of nuisance from all modes, its effects are localized, and greatest in residential locations exposed to high traffic volumes. Most of the noise from intercity passenger travel by road vehicles, trains and ferries is generated away from areas of dense habitation, but airplane noise is a very substantial nuisance close to major airports.

Derivation of an estimate of the cost of airplane noise is also briefly described in the Notes to Chapter 7 in this volume. Valued at $1.00 per passenger-trip system-wide, this noise cost becomes 0.07¢/pass-km over the representative trip of 1 478 km. This is included in the system-average environmental cost for airplane travel in Table 3-1 of Volume 1 and Table 3(2)-1.

No costs are included for noise in any of the other modes, partly because research has not provided comparable estimates for intercity

travel by the other modes, and partly because it is expected that such costs would be very small in relation to the other cost estimates and their ranges of uncertainty.

7. Accident Costs

The derivation of costs of damage in accidents is described in the Notes to Chapter 8 in this volume. Minimum losses per victim are estimated, from research on road accidents, as $330,000 per fatality and $10,000 per person injured, in 1990 prices. The alternative value of the losses per fatality, adopted recently by Transport Canada after researching individual willingness to pay for risk reductions, amounts to $1.5 million, in 1991 prices. That value has been adopted in the costing by mode that follows, together with $10,000 per person injured, where relevant.[33]

7.1 CAR ACCIDENT COSTS

The value for the social losses in all road accidents based on the Transport Canada values per casualty, together with estimates of other property damage losses, is estimated in Chapter 8 at about $14 billion, in 1991 prices.

To be compatible with the estimates of infrastructure costs, an estimate is needed of the amount of these losses that takes place on the paved provincial highway system. National road accident statistics show that some 65% of deaths and 30% of injuries were on roads with speed limits greater than 60 km/h. Those injuries and property damage accidents occurring on highways, however, are likely to be much more severe than the average (occurring at higher average speeds), and therefore to cost substantially more than the average.

The statistics also fail to show what proportion of highway accidents involves passenger vehicles. Strictly, deductions should be made for the losses attributable to non-passenger vehicles. The most important other group of vehicles is heavy trucks, because of their

over-involvement in severe casualties. Available statistics show them to be involved in about 3% of all accidents, and about 9% of deaths. But no information is available to determine responsibility for those accidents and casualties.

The simple assumption is made that 55% of the total accident damage cost is on highways and attributable to passenger vehicles, or a total of about $7.7 billion per year. Given its uncertainty, this figure is rounded to $8 billion. Averaged then across 210 billion total passenger kilometres by these vehicles, this would amount to about 3.8¢/pass-km. This figure appears in Table 3-1 of Volume 1 as the "total accident" cost for car travel.

Of this total amount, there is a proportion of health care costs for road accident victims that is not recovered from motor vehicle insurers, but borne instead by others. This is estimated in the Notes to Chapter 8 in this volume as about $300 million in total in 1990. Using the earlier assumption, 55% or $165 million of this would be attributed to highway passenger traffic. Averaging this over 210 billion passenger kilometres and inflating gives 0.082¢/pass-km in 1991 prices, which appears (suitably rounded) in the relevant cell in Table 3-1 of Volume 1.

The remainder of the 3.8¢/pass-km in losses is user borne, or 3.7¢/pass-km in the rounded figures of Table 3-1.

It should be noted that these estimates may conceal a large element of non-monetary cost, which is borne by the victims of accidents without compensation. (Monetary costs include loss of earnings as a result of death or injury.) Of the amounts estimated earlier to be borne by users, the largest part is borne in costs of accident insurance and the deductible amounts of damage claims paid personally by vehicle owners. However, being based on "willingness to pay," the estimates include a large portion that would represent non-monetary damage in accidents — remembering that monetary damage losses sum to only about $9.5 billion in 1991 prices. The other $4.5 billion

can be characterized as representing instead the emotional losses. If 55% of these occur in highway accidents, they amount to about $2.5 billion. These losses are probably not compensated fully, if at all, by those responsible for the accidents, or their insurance companies. The amount concerned is unknown, as the extent of compensation from insurance companies or directly from responsible owners/drivers is not recorded.[34]

It should be further noted that some part of those emotional losses are actually borne by non-users of motor vehicles — essentially pedestrians and bicyclists — in highway accidents (it being assumed that their monetary losses are compensated from insurance and health care systems). As these groups constitute about 15% of all road accident fatalities, they might account for 15% of the total emotional losses. The amount might be substantial compared with many of the component costs borne by non-users in Table 3-1. If total emotional losses were as great as $2.5 billion, and if 15% of that was borne by non-users of motor vehicles it would be close to $400 million. The amount is more likely some fraction of this. Any estimate would be entirely conjectural, however, so this cost has not been distinguished in the tables, and remains within the estimate of user-borne accident costs.

7.2 BUS ACCIDENT COSTS

The fatality rate in passenger operations is estimated in the Notes to Chapter 8 in this volume, from the (very sparse) information available on intercity bus accidents from Transport Canada, as 2.0 per billion passenger-kilometres. If Transport Canada's guidance of $1.5 million per death avoided is applied to these, a total of $3 million per billion passenger-kilometres, or 0.3¢/pass-km is obtained.

The accident statistics also show that the ratio of injured victims to fatalities was about 38 (265 injured versus 7 killed in the sample of jurisdictions and years considered). Applying Transport Canada's cost of $10,000 per injured victim, the ratio of injury cost to fatality

cost would be 0.20. Adding the injury cost to the fatality cost produces a combined cost of 0.36¢/pass-km.

Finally, an approximate allowance for property damage can be made, in the absence of statistics on the incidence of property damage accidents involving intercity buses, from the observation that the total costs estimated for property damage in road accidents amounts to about two thirds of the total costs of injuries. Adding this proportion would bring the system-average bus accident costs up to 0.4¢/pass-km.

Of this cost, some small amount would be borne by non-users, for similar reasons as for car accident costs. The amounts would probably be similar in proportion — about 2% of accident costs, or in this case only 0.008¢/pass-km. The relevant cell in Table 3-1 therefore shows 0.0¢/pass-km.

7.3 AIRPLANE ACCIDENT COSTS

For levels 1 and 2 carriers, the average fatality rate over the decade to 1990 is estimated in the Notes to Chapter 8 in this volume as 0.13 deaths per billion passenger-kilometres. At $1.5 million per fatality, that amounts to only 0.0195¢/pass-km.

The uncertainty of the fatality rate is underlined, however, by the fact that if the Nationair crash at Jeddah in 1991 is included the decade's fatality rate would change to 0.60 per billion passenger-kilometres, in which case, the cost would be about 0.09¢/pass-km.

The cost of injuries and property damage should be added to these costs. In air crashes, injuries are not numerous enough compared with fatalities to make much difference to the estimated cost. No estimates of the extent and costs of property damage in passenger aircraft accidents in Canada are available, but the price of passenger-carrying airplanes suggests that it could be significant. On the other hand, the average cost is unlikely to be as much as that estimated for

the victims; at Transport Canada's value of $1.5 million per person, even the most expensive modern airplane is worth less than its passengers.

In summary, it is concluded that the true cost of airplane accidents is unlikely to exceed 0.1¢/pass-km, which is the value used in the illustration.

As with bus accident costs, the amount of these air accident costs borne by non-users is expected to be so small that the relevant cell of Table 3-1 appears as 0.0¢/pass-km.

7.4 TRAIN ACCIDENT COSTS

The estimates in the Notes to Chapter 8 in this volume show the rate of all fatalities involving passenger trains over the decade to 1990 as 13.8 per billion passenger-kilometres. The great majority of these deaths were to motor vehicle users at grade crossings or people walking on the rail lines (including suicides). The question arises whether their costs should be attributed as a social cost of rail transport. In nearly all such cases, the railway is not legally at fault; though the deaths would clearly not have occurred in the absence of the trains. This issue is not resolved here, but for the illustrative costs, none of the costs of these other victims has been attributed to the train.

Deaths to passengers and rail employees in passenger operations, which are therefore assumed to be attributable to train travel, occurred at a rate of 1.16 per billion passenger-kilometres over the decade. Valued at Transport Canada's average of $1.5 million, the cost of these deaths amounts to 0.17¢/pass-km, in 1991 prices. To this should be added the costs of those passengers and employees injured in these accidents.

In the absence of details of the numbers injured in passenger operations during the decade, some indication of the long-term relationship between numbers killed and injured can be gained from the statistics for all main-line railway accidents, which show a ratio of 27 injured

for each death (976 injured compared with 36 killed over the decade). Using Transport Canada's road accident costs of $10,000 per average injured victim, this would add $270,000, or 18%, to each $1.5 million in costs of fatalities. This would raise the estimated system-average accident cost to 0.20¢ per pass-km.

The amount borne by non-users is again not zero, but expected to be so small that the relevant cell of Table 3-1 appears as 0.0¢/pass-km.

7.5 FERRY ACCIDENT COSTS

The fatality rate in ferry operations is estimated in the Notes to Chapter 8 in this volume as 0.5 deaths per billion passenger-kilometres. It is assumed that injuries are insignificant compared with deaths, as most deaths are by drowning (and given the differences in the average costs per victim injured and killed).

Valued at Transport Canada's cost of $1.5 million per person killed, the accident costs amount to 0.075¢/pass-km, which is quoted in Table 3-1 as 0.1¢/pass-km. Once again, the non-user portion is not zero, but negligible in Table 3-1.

8. VEHICLE/CARRIER COSTS AND SPECIAL TRANSPORTATION TAXES/FEES

8.1 CAR

As described in Volume 1 of this report, the term "car" is used as a shorthand reference for all private passenger vehicle use, most of which is in passenger cars, but with a significant proportion being in light trucks (30 billion passenger-kilometres, of a total on the "highway" system of 210 billion, or about 14%). Light trucks are mostly pickup trucks and passenger vans — defined as under 10,000 lb. (4 550 kg) laden weight, but nearly all under 6,000 lb. (2 725 kg) laden. Their cost characteristics are somewhat different from those of passenger cars; therefore, it is necessary to estimate costs for an average vehicle, blending costs for cars and light trucks in proportion to their use.

A report for the Royal Commission provided estimates of the costs of vehicle ownership and operation separately for cars and light trucks. Of these costs, insurance costs are included within user-borne accident costs, and vehicle licence costs and fuel taxes are included as special taxes/fees. Vehicle/carrier costs consist of the remaining costs of vehicle ownership and use. Costs for maintenance, depreciation and cost of capital are shown in Table 3(2)-7.[35] Estimates summarized in this table were provided for 1990 and are inflated to 1991 prices in the final column. The combined average figures weight the use of cars and light trucks by their total passenger-kilometres.

Table 3(2)-7
AVERAGE UNIT COSTS: CARS AND LIGHT TRUCKS

	$/veh per year (1990)	¢/veh-km (1990)	¢/pass-km (1990)	¢/pass-km (1991)
Cars				
Maintenance	409	2.3	1.3	1.4
Depreciation	1,230	7.0	3.9	4.1
Cost of capital	1,020	5.8	3.2	3.4
Light trucks				
Maintenance	409	2.3	1.5	1.6
Depreciation and cost				
of capital	2,030	11.3	7.5	7.9
Average passenger vehicle				
Maintenance	409	2.3	1.3	1.4
Depreciation and cost				
of capital	2,210	12.6	7.2	7.5

The cost of fuel is estimated for mid-1991 from a national average price (weighted by sales) of 55¢/L of gasoline, together with approximate average highway fuel consumption of 9 L/100 km for cars and 12 L/100 km for light trucks, together with average highway car occupancy of 1.8 passengers and light truck occupancy of 1.5 passengers. The cost for cars is 55/(100/9) = 4.95¢/veh-km, and 4.95/1.8 = 2.75¢/pass-km, and for light trucks 55/(100/12) = 6.6¢/veh-km, and 6.6/1.5 = 4.4¢/pass-km. Combined in proportion to passenger-kilometres driven, the blended average "car" fuel cost is 2.95¢/pass-km.

From this cost of fuel, the amount paid as special tax is deducted, and then appears as part of the "special tax/fee" item in the system average cost table instead of as a "vehicle/carrier" cost component. The relevant amount of tax is defined to be the amounts of provincial and federal taxes on gasoline in excess of the normal amounts of sales taxes charged in the jurisdictions concerned. The calculation is documented in Table 3(2)-8.

The federal excise tax of 8.5¢/L is included as part of the special charge for use of transport, but not the federal GST. Quebec's defined provincial excise tax is included without adjustment. In all other provinces, a motive fuel tax is charged instead of the normal provincial sales tax. Subtracting the amount that could have been charged as provincial sales tax leaves the component of the special charge for use of transport. The total of these charges averaged 17.8¢/L in 1991, when weighted by fuel use by province. Using the assumption of 9 L/100 km for cars, this special tax is therefore 1.6¢/veh-km, or 0.89¢/pass-km. For light trucks using 12 L/km it is 2.14¢/veh-km or 1.42¢/pass-km. The blended average for car is 0.95¢/pass-km. When combined with licence fees, which average 0.22¢/pass-km (see subsection 5.1.4), the total special transportation tax/fee for cars is thus rounded to 1.2¢/pass-km.

It is estimated that the net amount of fuel cost to be included in vehicle/carrier cost is, therefore, 2.95–0.95 = 2.0¢/pass-km. Total vehicle/carrier cost is the sum of the amounts estimated earlier for maintenance, depreciation and cost of capital, and fuel, or 1.4+7.5+2.0 = 10.9¢/pass-km (rounded) at 1991 prices.

Table 3(2)-8
FUEL TAX RATES PER LITRE: 1991 AVERAGE

	British Columbia	Alberta	Saskat-chewan	Manitoba	Ontario	Quebec	New Brunswick	Nova Scotia	Prince Edward Island	New-foundland	Canada Average
Federal Excise											
Gasoline	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Road diesel	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Aviation turbo	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Locomotive	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Provincial Special Tax — In Excess of the Standard Sales Tax Rate											
Gasoline	7.3	8.4	7.6	7.3	9.4	11.9	7.3	8.0	7.2	7.5	9.3
Road diesel	7.8	8.5	7.3	8.1	9.0	10.5	8.3	10.5	7.6	9.0	9.1
Aviation turbo	1.5	5.0	5.1	3.9	0.2	3.0	-1.4	-2.5	-2.7	-3.4	1.8
Locomotive	1.5	9.0	13.1	11.7	2.0	3.0	0.9	-3.1	9.0	-3.7	5.5
Total Special Taxes — Federal plus Provincial											
Gasoline	15.8	16.9	16.1	15.8	17.0	20.4	15.8	16.5	15.7	16.0	17.8
Road diesel	11.8	12.5	11.3	12.1	13.0	14.5	12.3	14.5	11.6	13.0	13.1
Aviation turbo	5.5	9.0	9.1	7.9	4.2	7.0	2.6	1.5	1.3	0.6	5.8
Locomotive	5.5	13.0	17.1	15.7	6.0	7.0	4.9	0.9	13.0	0.3	9.5

8.2 INTERCITY BUS

To generate the system-average costs of intercity passenger bus in Table 3-1 and the illustrative route examples of Tables 3-2, 3-3, 3-4 and 3-5, a simple method based on published data[36] was used.

	($ millions)
For classes 1 and 2:	
Taking operating expenses minus	316.4
bus depreciation expense	− 14.4
equals:	302.0
Attributing an estimated 75% to intercity	× 75%
passenger unit toll services gives:	227
Adding approximate average replacement-value-based depreciation and cost of capital ($32,000 multiplied by 1,273 buses)	+ 41
equals the total for classes 1 and 2	268
For total activity:	
Prorating for the intercity unit toll services of operators other than classes 1 and 2 (an additional 273 million pass-km or 8.3%) results in:	290
Allowing for a reduction in the level of activity from 1989 to 1991, in line with the long-term trend (2 years at −2.9%) provides:	274
Inflating 1989 dollars to 1991 dollars (2 years at 4.5%) gives a final total of:	299

This figure, $299 million, is the total to be found under users in Table 3-1(b). Divided by the estimate of 3.3 billion passenger-kilometres, it implies a system-average users cost of 9¢/pass-km.

The special tax/fee for bus travel consists of fuel tax and vehicle licence fees. Fuel use is estimated by Royal Commission staff to

average 0.405 L/bus-km, or 0.019 L/pass-km with average occupancy of 45%. Federal and provincial special taxes on diesel fuel, in excess of normal sales taxes, averaged 13.1¢/L in 1991. The average fuel tax was therefore 0.25¢/pass-km.

Provincial vehicle licence fees for intercity buses average about $500 per year,[37] or less than $0.5 million in total for about 1,000 buses engaged in intercity scheduled services in Canada. Averaged over 160 000 km per bus per year, the fee is less than 0.6¢/veh-km and at 45% occupancy is therefore 0.015¢/pass-km. Adding together fuel tax and licence fees gives a rounded average of 0.3¢/pass-km.

In considering the possible relaxation of economic regulation of the intercity bus industry (discussed in Chapter 13 of Volume 1), it was desirable to assess the importance of cross subsidization across different route types under the current regulatory regime. For this purpose, a much more detailed study of intercity bus carrier costing was undertaken; this study by Lake et al. is included in Volume 4 of this report.[38]

Two cost formulas were developed to reflect the differences between the major, large-scale carriers and the small-scale, often remote carriers. These formulas were based on cost and statistical data made available to Royal Commission staff on a confidential basis by various bus operators. For the study of cross subsidization within the intercity scheduled bus industry, the formulas were applied to a sample of actual routes, and the results examined as reported in Lake et al.

This method introduced output units into the costing, which allowed the cost characteristics of different types of routes to be captured. The usual measure used by the bus industry for cost analysis is the bus-mile.[39] However, for the analysis of cross subsidization, cost categories were attributed according to a notion of the relationship to bus-miles: using bus hours to reflect the different time to distance ratios of some services, and a per-passenger element to reflect costs that are variable with the volume of traffic (number of passengers)

but not with distance travelled. For most cost categories, there was insufficient consistency among the accounting definitions used by the various carriers to justify basing an estimate on averages. Rather, cost components from different sources were blended to achieve unit costs that appeared to represent a typical or normal level of cost.

Replacement value based depreciation and cost of capital charges for buses were included in the bus-hour cost:

Cost of new bus (1989–1990)	$260,000
Average life	10 years
Cost of 5-year-old bus	$100,000
End of life salvage	$20,000
Depreciation	straight line
Real cost of capital	10%

This results in an ownership cost per year for a new bus (assumed for the large-scale operations) of $38,000, and for a five-year-old second-hand bus (assumed for the small-scale operations) of $22,000. The unit cost reflecting bus time was calculated per scheduled bus hour. This made calculation of the cost for specific services easier, because the cost includes an idle or utilization factor. Analysis indicated that there are between three and a half and five buses owned for every one actually moving and carrying passengers on scheduled service at an average point in time. Overall, it was estimated that, for every hour that a bus is moving with passengers, it has spent or will spend more than three and a half hours in terminals, in a garage, or available for service. This factor was calculated using bus inventory, bus mileage and an estimate of average schedule speed of 40 or 50 mph (65 to 80 km/h). It only provided a rough approximation, but data required to make more dependable estimates were not available.

The calculated cost per passenger included a cost for terminals that represents terminal charges or rent (based on data from carriers that rent terminals). Some carriers own all of the terminals they use, some do not own any. Most of the large carriers own some terminals

and pay charges or rent for the shared or exclusive use of others. The owners of at least one major carrier own a terminal that is treated as a separate profit centre, charging the bus operation for its use.

The data were combined in an effort to present a reasonable approximation of the industry cost structure without disclosing data for any single contributor. It proved impossible to mask fully the costs of one or more of the large carriers; thus, only the qualitative conclusions, and not the specific cost estimates have been included in the study. The estimates could be used without endangering confidentiality, however, to develop differentials by which costs calculated for types of routes — used in the sample route tables of Chapters 3 and 18 of Volume 1 — differed from the system-average costs and fares outlined at the start of this section and presented in Table 3-1 of Volume 1.

8.3 AIRPLANE

The unit-cost development was based on an analysis of system data designed to allow some recognition of factors that contribute to differences in costs of different types of flights.

The analysis, however, does not consider network size or configuration, or a number of other reasons why marginal cost, or the cost of domestic services isolated from international operations, might depart markedly from the unit-cost estimates.

The estimates are based on 1989 data and a 1989 industry; in the case of the Level 1 carriers some modifications were made as later data became available. It may be noted that several of the carriers included in the data for independent jet carriers were, as of 1991, no longer operating. Developing an estimate of total air carrier costs for domestic services from the costs for a typical domestic air journey, however, avoids any biases that this might have created.

The air service costing was based on data provided by Statistics Canada, supplemented with information provided by airlines. These were allocated according to operational relationships, making use of a number of earlier studies.[40] This process benefited from the comments of Air Canada, Canadian Airlines International and the Air Transport Association of Canada.

The airlines' cost data do not separate freight from passenger operations. To the extent that passenger seats and (belly) freight capacity are jointly produced, separation for the present analysis was arbitrary. Because the purpose of the exercise was to develop passenger costs, and because freight carried by carriers represented approximately 10% of revenue, costs for Level 1 were reduced by 5%, presuming that one half of the freight was carried in belly space. Freight was not considered for carriers other than Level 1.

Air services available to passengers in Canada vary from single-engine charter float-planes to trans-Atlantic and trans-Pacific direct flights in B-747 aircraft with more than 450 seats. Scheduled carriers, Levels 1 to 3, account for 97% of Canadian carrier costs. The costing was performed separately for the Level 1 carriers (Air Canada and Canadian Airlines International), a sample of independent jet carriers (Nationair, Quebecair, Soundair, Worldways, Canada 3000, Execair, Holidair and Vacationair) and a sample of turboprop connectors or commuter carriers (Air Alliance, City Express, Ontario Express, Air Atlantic and Air Ontario).

Instead of the more conventional, strictly time-based approach, expense data were adjusted to remove aircraft depreciation expense and rentals, supplemented by a replacement value aircraft capital recovery charge at an interest rate of 10%, and attributed to four output units:

- seat-kilometres;
- seat-stages;

- passenger (same airplane) flights; and

- passenger trips.

The cost allocation for the Level 1 carriers for 1991 (1989 data adjusted to 1991 cost levels) is shown in Table 3(2)-9 on the following page. The table is based on costs of all passenger services, international and domestic. Treatment of the other carrier categories is briefer.

Although recent years have seen considerable fluctuation, an average load factor of 67.5% was taken — from Air Canada and Canadian Airlines International (PWA Corporation) annual reports — as representative of sustainable performance in this regard. Revenue passenger-kilometre, seat-kilometre, passenger-flight, revenue-passenger and other intermediate output units such as average stage,[41] flight and trip lengths (as estimated from Statistics Canada data, data provided by the airlines and airlines' annual reports[42]) allowed estimates of the necessary output units.

Unfortunately, the data did not always appear consistent. This imprecision, however, was not greater than that of the overall costing exercise and should not compromise the results. The uncertainty included average flight length and passenger-trip length; Statistics Canada counts flight coupons and hence overestimates trips where there are changes of planes. Estimates of an average 1.15 aircraft stages per flight and 1.16 flights per passenger trip[43] were based on data from Statistics Canada Catalogue No. 51-206, Table 2.3 and airline data; the Statistics Canada's Canadian Travel Survey[44] reported the 23 million passengers handled.

Flight-crew costs are allocated on the basis of flying hours. The literature (cited earlier) included regressions of Canadian airlines' turbo-jet flight time against distance. The regression selected (Moloney, 1985) was the most comprehensive. Flight-time estimates were calculated as a constant of 0.4006 hours per stage plus 0.0020 hours per mile. It is further noted that crew costs vary with aircraft type; smaller airplanes (that typically operate on shorter stages) generally have higher crew

Table 3/2I-9
Cost Allocation, Passenger Service, Level 1 Air Carriers, 1989 (1991$)

Output Units (millions)	Expense	Seat-km 75,000			Seat-stages 46			Passenger flights 27			Passenger trips 23		
		Alloc-ation	Total	Per unit	Alloc-ation	Total	Per unit	Alloc-ation	Total	Per unit	Alloc-ation	Total	Per unit
Air Operations													
Fuel	1,062.1	72%	764.7	0.01023	28%	297.4	6.52						
Flight crews	327.1	73%	238.7	0.00319	27%	88.3	1.94						
Landing, insur.	516.0				100%	516.0	11.32						
Air Maintenance													
Labour	206.6	44%	90.9	0.00122	56%	115.7	2.54						
Materials, other	425.5	44%	187.2	0.00250	56%	238.3	5.23						
In-Flight Services													
Cabin crews	287.5	57%	163.9	0.00219	43%	123.6	2.71	10%					
Food, supp, other	428.1	50%	214.1	0.00286	40%	171.2			42.8	1.60			
Terminal	942.0							60%	565.2	21.12	40%	376.8	16.38
Marketing	1,043.0										100%	1,043.0	45.35
Air Capital	512.8	44%	225.6	0.00302	56%	287.2	6.30						
Total	5,750.6			0.02521			36.55			22.72			61.73

costs per seat-stage and seat-kilometre. The analysis did not allow for this.

Fuel was attributed to flight hours, with a small allowance for taxiing. Cabin-crew costs were allocated on the basis of flying hours plus 40 minutes per stage. Maintenance cost and the physical wear of a turbojet airplane are attributed partially to cycles (takeoff, pressurization, de-pressurization, landing) and partially to flying hours. A figure of 40% attributable to cycles (Aviation Planning Associates, 1983) yields estimates of 44% attributable to seat-miles and 56% to seat-stages.

Because most airplane accidents occur at takeoff or landing, insurance, with landing fees, was attributed entirely to these activities. For terminal costs, the only data found that matched the definition used here were old (Bajwa and Shurson, 1981). These were escalated using an approximate construction cost index.

The cost aggregate termed "marketing" includes travel agents' commissions that are generally paid as a percentage of revenue. Using this would introduce a further output unit; however, at the basic level (cost to the agent), passenger-trips would seem a reasonable variable. General and administrative cost, presumably relating to corporate administration, was allocated to all of the preceding items.

Computations for levels 2 and 3 are similar. To convert costs per seat-mile into figures appropriate for comparisons, an average load factor of 67.5% was applied to the Level 1 data. For the connectors/commuters it was estimated as 56%, and for the independent (charter) jet carriers where load factor data were not available, 80% was assumed. It is noted that, perhaps more than any other parameter, the assumption of a uniform load factor distorts route and service comparisons.

System-average costs are calculated by service type as shown in Table 3(2)-10.

Table 3(2)-10
AIR CARRIER AVERAGE UNIT COSTS (IN 1991 DOLLARS)

	Passenger-kilometre ($)	Passenger-stage ($)	Passenger-flight ($)	Passenger-trip ($)
Level 1	0.0373	54.15	22.72	61.73
Commuter	0.0961	39.50	8.73	17.28
Charter jet	0.0467	62.81	10.91	13.97

As an example, the computed average per-passenger cost for a trip from Saskatoon to Halifax (Level 1 carrier) with a change of airplanes in Toronto would be:[45]

3 500 km	at $ 0.0373	$130.55
2 stages	at $54.15	108.30
2 flights	at $22.72	45.44
1 trip	at $61.73	61.73

		$ 346.02

8.3.1 System-Average Domestic Air Trip, 1991

Statistics Canada and the airlines do not keep cost and revenue data for domestic travel. It would not be logical to attempt to keep accounts under that structure; domestic, Canada–United States and international services are operated as an integrated network. The cost characteristics of the different services are, however, quite different. The overseas international services with long average flight and stage lengths, using larger aircraft, differ particularly. To estimate domestic-system-average and system-total costs, a typical trip of 1 478 air kilometres was defined as indicated by Statistics Canada's and other available data. It is noted that these data on flight characteristics are for all airlines (Levels 1 to 3) and for domestic services in isolation; however, the system-average-cost estimate is based on Level 1 carrier cost factors.

Computed carrier cost	1 478 kilometres	at $0.037	$55
	1.6 stages	at $54	86
	1.4 flights	at $23	32
	1 trip	at $62	62
			$235

This yields an average cost of 15.9¢/pass-km to which another $20, or 1.4¢/pass-km, Air Transportation Tax may be added — for a total of 17.3¢/pass-km. The average ticket yield was, however, estimated to be $222 for a trip of this length[46] (15¢/pass-km), or $242 (16.4¢/pass-km) with the Air Transportation Tax. These estimates suggest that the airlines are operating at a loss of 0.9¢/pass-km if one includes a return on capital invested in aircraft.

While these estimation methods are not precise, in the short run it is true that losses are being incurred. It is not, however, reasonable to expect such a condition to persist for very long. To model a more representative steady state condition, it was assumed that the difference will ultimately be made up through price increases averaging approximately 6%.

Special tax/fee costs for air travel consist only of the applicable fuel tax. Royal Commission staff estimate that average fuel consumption for domestic air services is 0.103 L/pass-km. The special tax rate applicable to aviation turbo fuel was 5.8¢/L in 1991. The average tax was therefore 0.6¢/pass-km.[47]

8.4 RAILWAY PASSENGER

For practical purposes, when one considers the cost of railway passenger services in Canada, one may limit the consideration to VIA Rail. VIA Rail accounts for 95% of the industry's passenger-kilometres, and the other carriers' unit costs are of the same general order as VIA Rail's. As well, since VIA Rail is exclusively a passenger carrier, no separation of freight from the passenger operations is required in analyzing its data.

The Royal Commission's intercity rail-carrier costing is described in Volume 4 of this report.[48] For the most part, the service costing was based upon VIA Rail's 1990 year-end results. Data for 1989 were available and were used in circumstances where the substantial service rationalization that occurred in January 1990 would have distorted the 1990 results, making them unrepresentative of the longer term.

Overheads and indirect costs included: functional overheads, general corporate overheads, shared facilities and operations, plus the cost of capital on equipment and facilities. The costs used for the year 2000 status-quo costs of Chapter 18 are steady-state in the sense that allowance has been made for improvements in the cost experience of passenger rail.

System-total data for 1991, as shown in Table 3-1 of Volume 1, were estimated from recently available 1991 VIA Rail data, plus escalated 1987 data for BC Rail, and the Algoma Central, Ontario Northland and Quebec North Shore and Labrador Railways. Total Canadian railway passenger revenues and costs, and VIA Rail's share, are:

	$ million (1991)		
	VIA Rail	Other	Total
Passenger revenue	144	10	154
Operations subsidy	353	38	391
Depreciation and cost of capital[49]	62	included	62
Total			607

Special tax/fee costs for train travel consist of the fuel taxes paid that would be in excess of the normal sales taxes. Average fuel consumption was estimated by Royal Commission staff as 0.043 L/pass-km. Combined with the average special tax-rate on locomotive fuel of 9.5¢/L in 1991, the tax amounted to 0.4¢/pass-km.

8.5 FERRY

Cost estimates are based on a research report to the Royal Commission.[50] The report provides cost, revenue and traffic records for the three major ferry corporations: British Columbia Ferry Corporation, Marine Atlantic Inc. and Northumberland Ferries Ltd., which together provide about 95% of Canada's total ferry passenger-kilometres. Estimates of average costs and revenue per passenger-kilometre are developed for these three operations combined and used to represent all domestic intercity ferries. Other intercity services included are the Central Region Ferries in the Great Lakes (Tobermory to South Baymouth) and St. Lawrence (Matane to Godbout; Matane to Baie Comeau; Rivière du Loup to St. Siméon; Trois Pistoles to Les Escoumins), and the Atlantic region service from Souris to the Magdalen Islands. On the other hand, limiting the focus to domestic services means that the service by Marine Atlantic between Yarmouth and Bar Harbor is consequently excluded, as are services such as Victoria to Seattle, Sidney to Anacortes, Victoria to Port Angeles and Yarmouth to Portland.

Costs and revenues are for the fiscal year 1990-91, but are assumed adequate to represent 1991 conditions and 1991 prices. Capital charges were estimated including depreciation and a capital charge on the remaining value of the assets, in a manner similar to that described for air infrastructure. Costs and revenues were estimated per passenger-vehicle-kilometre; that is, vehicle-kilometres by passenger vehicles, as opposed to trucks. These were distinguished by allocating the costs between freight vehicles and passenger vehicles on the basis of space used by the vehicles, measured in "automobile-equivalent" units (an average heavy truck being about three automobile-equivalents). The resulting estimates are:[51]

	Costs	Revenues
	($/passenger-vehicle-kilometre)	
BC Ferries	0.91	0.76
Marine Atlantic	1.98	0.85
Northumberland Ferries	2.28	1.01

8.5.1 Exclusion of Food Services and Other Merchandise Retailing

As for the other modes (in particular airports), costs and revenues attributable to commercial activities other than providing passenger service, and not included in the ticket price, were subtracted from the ferry data. This included cost and revenue related to catering services and other sales of goods. The accounts provided for BC Ferries and Marine Atlantic offer the relevant information (for the former, "cost of food and goods sold" and "catering and other income"; for the latter, "vessel services revenues"). The calculation, in fact, deducts revenue rather than costs, on the assumption that the revenue recovers not only the costs of the materials concerned, but also an appropriate proportion of crew and vessel costs. (This is a tenuous assumption, which probably overstates the costs concerned and so produces a slight underestimation of the remaining transportation costs.)

The arithmetic of removing catering and other sales was:

• For BC Ferries, to estimate them as a proportion of the "ships" costs, and to deduct this proportion from the "vessels" costs per passenger-vehicle-kilometre;

• For Marine Atlantic, to estimate them as a proportion of the "vessels" expenses, and to deduct this proportion from the "vessels" costs per passenger-vehicle-kilometre; and

• For Northumberland Ferries, no information on such costs was available and no deduction was made.[52]

8.5.2 Exclusion of Excess Vessel Costs Arising Through Local Construction

Capital cost estimates, and thus total vessel costs, were modified to remove the excess amount incurred through purchasing local construction, as opposed to the lowest-cost (off-shore) alternative. This modification of the estimates of costs is in accordance with the Royal Commission's intention that costs incurred by government in pursuit of non-transportation goals be charged to general revenues — implying that those vessel costs arising from an intention to support Canadian shipbuilders, beyond a level provided by standard import tariffs, should not be included in the costs that users are asked to pay.

The amounts of vessel costs concerned can be estimated only very approximately. From a brief tabulation of some prices paid recently for large ferries in Canada and overseas, it appears that the premium for Canadian construction might be of the order of 50% to 100% of the off-shore price.[53] Some corroboration is provided by comparisons of costs for other types of vessels; for example, a price for construction in Canada of a seaway-size bulk freighter is double that of one built in Korea.[54] To the off-shore prices must be added 25% duty, but the differential remains substantial.

For illustrative purposes, it is assumed that the premium for local construction amounts to 33% of the capital cost of the vessel. This proportion is therefore deducted from the vessel capital costs included in the accounts for Marine Atlantic and BC Ferries. The vessel costs are not separately identified for Northumberland Ferries, so no such deduction is made; but the effect of this omission on the system average costs is negligible.

The resulting costs per passenger-vehicle-kilometre, amended for both food services (cost and revenue) and local vessel construction premiums, are:

	Costs	Revenues
	($/passenger-vehicle-kilometre)	
BC Ferries	0.73	0.62
Marine Atlantic	1.74	0.71
Northumberland Ferries	2.28	1.01

8.5.3 Estimation of Costs per Passenger-Kilometre

The earlier cost and revenue estimates attempted to exclude all elements relating to freight transportation. In estimating the costs per ferry passenger-kilometre for comparison with the other modes, it is necessary to distinguish the passengers on ferries who travel in passenger vehicles from the occupants of freight vehicles, who are also described as passengers in the ferry statistics. Assuming 1.1 occupants per commercial vehicle, there were 637,000 passengers in commercial vehicles, or 2.8% of the total of some 22.8 million passengers in 1990-91, for the three companies. Because the commercial vehicle passengers are so small a proportion of total passengers, the subsequent estimate of total passenger-kilometres is clearly not very sensitive to the guessed number of occupants per commercial vehicle.

For BC Ferries and Marine Atlantic, this procedure for estimating "non-commercial passenger-kilometres" was applied to each of the services, allowing overall estimates of 640 million passenger-kilometres for BC Ferries and 135 million passenger-kilometres for Marine Atlantic. For Northumberland Ferries, the amended estimate is 12.07 million passenger-kilometres. Expressed alternatively as numbers of passengers per passenger-vehicle carried by the three companies, the results are as shown in the second column of Table 3(2)-11. The cost and revenue estimates in the previous tables can be divided

by these estimates of passengers per vehicle to give costs and revenues per "non-commercial passenger-kilometre" in the final two columns of Table 3(2)-11.

Table 3(2)-11
AVERAGE FERRY UNIT COSTS AND REVENUES

	Passengers per passenger-vehicle	Costs ($ pass-km)	Revenues ($ pass-km)
BC Ferries	2.59	0.282	0.239
Marine Atlantic	2.43	0.718	0.292
Northumberland Ferries	2.48	0.921	0.408
Average		0.366	0.250

The system-average vehicle/carrier cost estimate for ferries is therefore 36.6¢/pass-km, and the "user-borne" portion is 25¢/pass-km.

In the illustrative tables of Volume 1, Chapters 3 and 18, amounts borne by vehicle users/carriers and passengers for accident costs and special transportation taxes/fees are shown separately. In the case of ferries, all of these costs are included in the estimated averages of 36.6¢/pass-km and 25¢/pass-km; thus, they must be deducted to show the remaining vehicle/carrier costs.

8.5.4 Estimation of Special Tax/Fee for Ferry

As the first step in the calculation of special taxes, the amount of fuel used in the ferry services must be estimated per passenger-kilometre. Marine Atlantic provided data for the company's fuel purchases and expenditures over a three-year period.[55] Direct estimates of fuel used by BC Ferries and Northumberland Ferries were not available; estimates based on their expenditures on fuel[56] in 1990, together with an assumed average price of 26.5¢/L plus provincial tax, were used. These estimates suggest a combined total fuel consumption of about 195 million litres for the three ferry companies.

These estimates of consumption were then allocated between freight and passenger vehicles for each company in the same manner as were costs; that is, according to proportions of auto-equivalent units transported. Then the estimates of total (non-commercial) passenger-kilometres for the three companies were used to calculate litres of fuel consumed per passenger-kilometre. The resulting estimate is 0.191 L/pass-km.

The average special tax payable per litre for these ferry services was then calculated. This involved a calculation analogous to that for the special tax component of prices of gasoline used in cars, as discussed earlier. Federal excise and provincial fuel taxes paid, by province, in 1991, on marine fuels are shown in Table 3(2)-12. The amount of provincial tax that would have been payable had the normal sales tax rate been applied to the price of marine fuel was then calculated — also shown in Table 3(2)-12. Finally those amounts were deducted from the total of the federal excise and provincial taxes paid to obtain the net amounts of special transportation tax paid.

Table 3(2)-12
SPECIAL TAX CALCULATION: FERRY
(TAXES IN 1991¢/L OF MARINE FUEL)

	Nfld.	P.E.I.	N.S.	N.B.	B.C.
Federal excise	4.0	4.0	4.0	4.0	4.0
Provincial tax	0.0	0.0	1.2	0.0	3.34
Tax at PST rate	3.9	3.3	3.3	3.6	1.5
Net special tax	0.1	0.7	1.9	0.4	5.8

To estimate the amounts of fuel used in the east-coast services bought in each province, it is simply assumed that half the fuel used in each of the ferry services is purchased at each end of the trip. The weighted average tax rate paid on the Marine Atlantic services would then be 0.96¢/L, on Northumberland Ferries' services 0.55¢/L, and on the BC Ferries' services, as shown in Table 3(2)-12, 5.8¢/L.

Then, by multiplying these taxes by the estimated consumption per passenger-kilometre, the average special fuel tax payment for all the ferry services is estimated as 0.87¢/pass-km. This is included in the system-wide costs in Table 3.1, appearing as 0.9¢/pass-km when rounded.

The amount of this tax must be deducted from the vehicle/carrier costs together with ferry accident costs, estimated at 0.075¢/pass-km. Resulting user-borne vehicle/carrier costs are reduced from the 25¢/pass-km estimated earlier, to 24.1¢/pass-km, while total vehicle/carrier costs are reduced from 36.6¢/pass-km to 35.7¢/pass-km.

9. COSTS FOR SAMPLE ROUTES

9.1 CAR

For simplicity, in these illustrations most of the costs of car use are assumed to be constant per kilometre, regardless of route. In reality, vehicle fuel consumption would differ among the routes, being determined by such factors as travel speed and the extent of congestion. Vehicle maintenance and depreciation per kilometre would also vary by those factors, and be influenced by the quality of the highway pavement. Accident risks and, therefore, expected accident costs, are also known to vary by route and traffic conditions. Nevertheless, it is assumed here that such variations are not important to the major purpose of these estimates, which is to show the orders of difference in costs by mode, and subsequently (in Chapter 18) to show the future cost changes expected. Each of these classes of costs is therefore assumed to be the same per vehicle-kilometre on all of the sample routes as the system-wide averages estimated earlier. Also for simplicity, and in the absence of much information, average vehicle occupancies are assumed constant for all sample routes, so these categories of costs remain the same per passenger-kilometre as the system-wide averages.

The exceptions are the highway infrastructure costs and the environmental costs, which are assumed to vary by route, as described in subsections 9.1.1 and 9.1.2.

9.1.1 Costs of Infrastructure

The estimates of highway construction and maintenance costs prepared by Nix et al. and shown in Table 3(2)-3, earlier, differ substantially by class of highway. Adding the cost of capital to those estimates, and inflating to 1991 prices, produces the costs per vehicle-kilometre, which appear in the second column of Table 3(2)-13(i). The proportions in which each class of highway are represented differ among the sample routes, so the average infrastructure cost should also differ by route. The proportions have been estimated only roughly by Royal Commission staff. The estimates made for the four sample routes in Volume 1, Chapter 3 and also for the additional routes in Chapter 18, are as shown in part (i) of Table 3(2)-13.

Part (ii) of Table 3(2)-13 then shows the resulting estimates of costs averaged over the highway types for each of the routes, expressed as costs per vehicle-kilometre and per passenger-kilometre. It can be seen that they differ substantially, being lowest for the all-expressway route between Toronto and Montreal and greatest for the predominantly low-density rural highway route between Winnipeg and Gillam.

The estimates of car infrastructure costs for the sample routes are produced by adding the system-average cost of infrastructure control per passenger-kilometre from subsection 5.1.4., of 0.22¢/pass-km, to the costs per passenger-kilometre in Table 3(2)-13. In addition, for the route from Toronto to Montreal an estimate of the highway land cost of 0.3¢/pass-km, or $1.60 per passenger-trip, is included. Land costs are ignored on the other routes, as they are expected to be much less important within the trip totals.

Table 3(2)-13

HIGHWAY CONSTRUCTION AND MAINTENANCE COSTS FOR SAMPLE ROUTES, INCLUDING COST OF CAPITAL, IN 1991 PRICES

(i) Costs per vehicle-km, and route distance by class of highway

Highway class	Costs (¢/veh-km)		Assumed distance on sample routes by highway type					Halifax–St. John's	
			Toronto–Montreal	Saskatoon–Halifax	Val d'Or–Montreal	Vancouver–Toronto	Winnipeg–Gillam		
	Car	Bus	(km)	(km)	(km)	(km)	(km)	via Port aux Basques (km)	via Argentia (km)
Expressway	1.091	1.955	539	1,300	114	1,360	0	110	110
Paved highway:									
– top 10%	1.626	3.048	0	1,592.5	0	1,566	200	578.5	179.5
– middle 30%	3.933	7.754	0	1,592.5	336	1,566	875	578.5	179.5
– bottom 60%	10.486	20.980	0	0	0	0	0	0	0
Total route distance	—	—	539	4,485	450	4,492	1,075	1,267	469

Sources: Costs by highway type from estimates by Nix et al., including capital charges estimated by Royal Commission staff, and inflated to 1991 prices. Route distances by highway type estimated by Royal Commission staff.

Table 3(2)-13 (cont'd)
HIGHWAY CONSTRUCTION AND MAINTENANCE COSTS FOR SAMPLE ROUTES, INCLUDING COST OF CAPITAL, IN 1991 PRICES

(iii) Average costs by car and bus for sample routes

Highway class	Toronto–Montreal	Saskatoon–Halifax	Val d'Or–Montreal	Vancouver–Toronto	Winnipeg–Gillam	Halifax–St. John's	
						via Port aux Basques	via Argentia
Car costs:							
Average cost/veh-km (¢)	1.091	2.290	3.213	2.268	3.504	2.633	2.383
Average cost/pass-km (¢)	0.627	1.316	1.846	1.304	2.014	1.513	1.370
Bus costs:							
Average cost/veh-km (¢)	1.955	4.402	6.285	4.358	6.878	5.102	4.593
Average occupancy (pass/veh)	36.19	27.00	21.15	27.00	21.15	20.00	20.00
Average cost/pass-km (¢)	0.054	0.163	0.297	0.161	0.325	0.255	0.230

Source: Bus occupancy by route estimated by Royal Commission staff.

9.1.2 Environmental Costs

As well as differing because of trip lengths, costs of environmental damage are expected to differ among the illustrative routes because of the different distances travelled within the ozone non-attainment areas (ONAs). In fact, because fuel consumption, and implicitly other engine operating conditions, are assumed constant among the routes, emissions are also constant per vehicle-kilometre. The cost for CO_2 (at 3.27¢/kg, as described in the Notes to Chapter 7 in this volume) is therefore also constant per vehicle-kilometre for all routes, at about 0.73¢, or 0.41¢/pass-km.

The cost of emissions of NO_x and VOCs, however, is assumed to be $5/kg only within the ONAs, and only during summer. Otherwise the cost is zero. The portion of each of the sample routes assumed to lie within the ONAs is shown in Table 3(2)-14, for the other modes as well as for car travel. Emissions per vehicle-kilometre are assumed constant during each trip; therefore, the proportion of trip-kilometres within the ONAs represents the proportion of trip emissions within those areas. The fraction of emissions that occur in summer is assumed to be constant at 40%. That portion of the total NO_x and VOCs emissions on each route in ONAs in summer is multiplied by $5/kg to obtain the cost for each route.

A more comprehensive explanation of the derivation of the costs on two of the sample routes, Toronto to Montreal and Saskatoon to Halifax, forms part of the Notes to Chapter 7 in this volume.

9.2 BUS

9.2.1 Costs of Infrastructure

The costs for highway construction and maintenance per bus-kilometre estimated by Nix et al., in Table 3(2)-3, also differ substantially by class of highway, and therefore vary among the sample routes as the types of highways represented differ. Distances by class of highway are assumed to be as described for cars, shown in Table 3(2)-13(i).

Table 3(2)-14
TRIP DISTANCES BY MODE, AND DISTANCES IN OZONE NON-ATTAINMENT AREAS FOR SAMPLE ROUTES

| | Toronto–Montreal | | Saskatoon–Halifax | | Val d'Or–Montreal | | Vancouver–Toronto | | Winnipeg–Churchill | | Halifax–St. John's | | | |
| | | | | | | | | | | | via Port aux Basques | | via Argentia | |
	km	km in ozone non-attainment areas	km	km in ozone non-attainment zones	km	km in ozone non-attainment zones	km	km in ozone non-attainment zones	km	km in ozone non-attainment zones	km	km in ozone non-attainment zones	km	km in ozone non-attainment zones
Car	539	539	4,485	650	450	114	4,492	250	—	—	1,267	0	469	0
Bus	539	539	4,485	650	450	114	4,492	250	—	—	1,267	0	469	0
Train	540	540	4,468	400	700	200	4,467	250	1,375	0	—	—	—	—
Airplane[a]	496	100	3,500	100	425	50	3,365	100	1,000	0	875	0	875	0
Ferry	—	—	—	—	—	—	—	—	—	—	178	0	519	0

Source: Royal Commission staff estimates.

a. Airplane kilometres in "ozone–sensitive areas" assumed to be 50 km per trip-end within such areas.

The second column shows the costs per vehicle-kilometre for buses by class of highway.

Part (ii) of the same table shows the weighted average cost per bus-kilometre over each route. As for cars, the lowest cost per vehicle-kilometre is incurred over the expressway route between Toronto and Montreal, and the highest over the low-density rural highway route between Winnipeg and Gillam.

The table then shows, in the next-to-last row, the Royal Commission staff estimates of average bus occupancies over routes of these types, and the last row shows the average cost per passenger-kilometre by route, obtained by dividing the cost per vehicle-kilometre by the occupancy on each route.

9.2.2 Environmental Costs

Emissions of CO_2, NO_x and VOCs from buses are assumed to be constant per litre of fuel used, as described in the Notes to Chapter 7 in this volume. They therefore vary per vehicle-kilometre by route only to the extent that fuel use per vehicle-kilometre varies, and also vary per passenger-kilometre to the extent that bus occupancies differ.

Fuel use per bus-kilometre is estimated by Royal Commission staff to be constant at 40 L/100 bus-km on most of the sample routes. Occupancies are assumed to vary by route as was shown in Table 3(2)-13(ii). The resulting fuel use per passenger trip for buses is shown in Table 3(2)-15, which also includes fuel use in the other modes. Emissions by route are obtained by converting the fuel use into CO_2, NO_x and VOCs emissions by the factors implicit in Table 7(2)-1 and 7(2)-2, which appear later in this volume.

Then costs of the emissions by route are calculated as described above for cars. Total trip emissions of CO_2 are multiplied by the assumed cost of 3.27¢/kg. Emissions of NOx and VOCs are first multiplied by the portion of trip-kilometres in the ONAs, also shown in Table 3(2)-15, and by 40% to represent summer; then remaining emissions are multiplied by $5/kg.

Table 3(2)-15
FUEL USE PER PASSENGER-TRIP BY MODE ON SAMPLE ROUTES

| | Toronto–Montreal | | Saskatoon–Halifax | | Val d'Or–Montreal | | Vancouver–Toronto | | Winnipeg–Churchill | | Halifax–St. John's via Port aux Basques | | Halifax–St. John's via Argentia | |
	L/pass	% in ozone non-attainment areas	L/pass	% in ozone non-attainment zones	L/pass	% in ozone non-attainment zones	L/pass	% in ozone non-attainment zones	L/pass	% in ozone non-attainment zones	L/pass	% in ozone non-attainment zones	L/pass	% in ozone non-attainment zones
Car	27.0	100	224.3	14	22.5	25	224.6	6	—	—	63.4	0	23.5	0
Bus	5.9	100	67.0	14	8.6	25	67.0	6	—	—	23.0	0	8.0	0
Train	15.0	100	283.3	9	102.9	29	270.0	6	260.0	0	—	—	—	—
Airplane[a]	40.8	69	219.2	16	46.3	60	120.0	23	80.8	0	67.2	0	53.8	0
Ferry	—	—	—	—	—	—	—	—	—	—	34.4	0	100.3	0

Source: Royal Commission staff estimates.

a.   Airplane fuel use in takeoff/landing assumed to be 35 litres per passenger.

9.3 TRAIN

9.3.1 Costs of Infrastructure

The infrastructure costs, as for the carrier costs, are taken from data provided by VIA Rail and Transport Canada. Infrastructure costs are presumed to be payments to the freight railways for the service in question.

9.3.2 Environmental Costs

Emissions are assumed to be constant per unit of diesel fuel energy, as shown in Table 7(2)-1 in this volume. Estimated diesel-fuel use per passenger-trip for each sample route is shown in Table 3(2)-15. The two are combined to give emissions of CO_2, NO_x and VOCs per passenger-trip. Total CO_2 emissions are multiplied by a cost of 3.27¢/g. Costs of NO_x and VOCs are calculated by applying the unit cost of $5/kg to the portion of emissions released in the ONAs (from the trip-kilometres in ONAs in Table 3(2)-15) in summer (40%).

9.4 AIRPLANE

9.4.1 Costs of Infrastructure

The allocation of air infrastructure costs to individual sample routes is illustrated in subsection 5.3.3 of this Chapter.

9.4.2 Environmental Costs

Emissions are again assumed to be constant per unit of fuel energy among the sample routes, at rates shown in Table 7(2)-1 of this volume. Estimates of fuel use per passenger-trip are provided in Table 3(2)-15. The two are combined to give emissions of CO_2, NO_x and VOCs per passenger-trip.

Total CO_2 emissions are multiplied by a cost of 3.27¢/g. Amounts of NO_x and VOCs occurring in the ONAs are calculated somewhat differently for aircraft than for the other modes. Instead of using the

proportion of route-kilometres that lies within the ONAs, it is assumed that the aircraft fuel used on the ground, climbing and descending at airports within the ONAs contributes to low-level ozone, while fuel used at cruising altitude does not. The relevant amount of fuel (for aircraft of a Level 1 carrier) is estimated by Royal Commission staff to be about 35 litres per passenger-stage. The proportion this represents of fuel used per passenger-trip by route is shown in Table 3(2)-15. This proportion of trip emissions, multiplied by 40% to represent summer, is multiplied by $5/kg to obtain the NO_x/VOCs cost per passenger-trip.

9.5 FERRY

No route-specific ferry costs are shown in Chapter 3, but 1991 costs for ferry routes are included in Chapter 18. The examples in Chapter 18 are of the two ferry routes between Nova Scotia and Newfoundland. Costs per passenger-kilometre for infrastructure and accidents are assumed to be the same as the system average.

9.5.1 Vehicle/Carrier Costs

Costs for the two routes are obtained from the research report that provided the system-average costs.[57] The same procedures described earlier for the system-average costs were used to remove costs of food services and excess vessel costs arising from local construction, and to estimate fuel costs and taxes in order to distinguish the special tax/fee for the routes.

9.5.2 Environmental Costs

Emissions are again assumed to be constant per unit of fuel energy, as shown in Table 7(2)-1. Fuel use on the two illustrative ferry routes is assumed to be the same per ferry-kilometre, and per passenger-kilometre, and therefore differs per passenger-trip only by route length, as shown in Table 3(2)-15. No costs for NO_x and VOCs are assessed on either of these routes, as their emissions are assumed to occur entirely outside the ONAs.

ENDNOTES

1. Cross subsidy, in this context, implies that the hypothetical service in question makes more than the average contribution to fixed cost. Most economists would not use this (implied) definition of cross subsidy.

2. Estimates developed from Statistics Canada, *Passenger Bus and Urban Transit Statistics*, Catalogue No. 53-215, 1989; bus fuel consumption data; bus company accounts; and assumed load factors.

3. Treasury Board of Canada, *Benefit-Cost Analysis Guide* (Ottawa: Supply and Services Canada, 1976).

4. There are two methods of accounting for capital costs: investment expenditures can be included in total costs in the year in which they are made, or they can be amortized over time in such a way that the stream of annual "depreciation charges" and of annual "interest charges" (or return on capital) has the same discounted present value as the initial investment expenditure. The latter approach gives a smoother stream of annual costs and provides a better estimate of the cost of using the facility in a particular year. The Royal Commission's cost analysis work uses this amortized cost approach; a real rate of return of 10 percent, applied to one-half the replacement value of the facility, is used to estimate the "interest charge."

5. F. P. Nix, M. Boucher and B. Hutchinson, "Road Costs," in Volume 4 of this report.

6. Ashish Lall, "Transportation Infrastructure Costs in Canada," in Volume 4 of this report.

7. Z. Haritos, *Rational Road Pricing Policies in Canada* (Ottawa: Canadian Transport Commission, 1975), and Strategic Policy Directorate, Transport Canada, *Transport Costs and Revenues in Canada* (Ottawa: Transport Canada, July 1982).

8. The term "expressway" is used to denote a limited access highway.

9. An alternative means of estimating the capital value of the highway stock would be creating average lifetime profiles of costs of construction and repair per kilometre for highways of various qualities, and combining them with estimates of the age profiles of various parts of the network. The necessary unit costs — particularly of costs of new construction of highways of various qualities — and age profiles are not available. Some possible indication of the relevant amounts can be obtained using costs of reconstruction from the report by Nix et al., "Road Costs," to represent costs of new construction (which understates construction costs by the amounts needed for preparation, grading, drainage, etc.). By adding resurfacing and reconstruction costs as also indicated by that report, lifetime profiles of costs by type of highway can be created. Then, assuming highways are of average age (that is, that construction was spread evenly over the last 45 years or so), the following current capital values can be estimated:

		$ million (at 1989 prices)
Expressways		1,860
Paved rural highways	top 10%	1,630
	middle 30%	4,160
	bottom 60%	7,920
Total		15,600

A capital charge at 10% on that total would amount to $1.56 billion per annum. When allocated by vehicle type by passenger car equivalent units, this charge per passenger kilometre for an average car/light truck would amount to approximately 0.5¢/pass-km.

This method would produce the same cost as does the guesswork in the text — that is, close to 1¢/pass-km — if the true unit costs of new construction (per kilometre) were about double those drawn from Nix et al. for reconstruction. It seems quite probable that new construction costs are that much higher.

10. J. J. Lawson, "Available resources for efficient accident prevention," in *IIIe Congrès Mondial de la Prévention routière internationale* (PRI) (Luxembourg: PRI, 1989), pp. 34–47.

11. Pilorusso Research & Consulting Inc., "The Cost of Inter-City Travel by Private Motor Vehicle," a report prepared for the Royal Commission on National Passenger Transportation, RR-05, August 1991.

12. Deliberately ignoring the tolls on international bridges, recognizing that the costs of those bridges do not appear in provincial/federal roads budgets, and are therefore not included in our costs.

13. British Columbia Ministry of Transportation and Highways, *Annual Reports*, 1988–89 and 1989–90.

14. Personal communication, British Columbia Ministry of Transportation and Highways.

15. Maximum gross weight quoted for "B-train double," with exceptions being in Ontario and Yukon, where the limit is 63.5 tonnes. See Council of Ministers of Transportation and Highway Safety, Interjurisdictional Committee on Vehicle Weights and Dimensions, *Summary of Weight and Dimension Regulations for Interprovincial Operations, Resulting from the Memorandum of Understanding on Interprovincial Weights and Dimensions*, September 1989 (available from Canadian Council of Motor Transport Administrators, Ottawa).

16. Nix et al., "Road Costs."

17. Ibid., from Table E.6, average obtained from weighting by vehicle-kilometres by class of highway, and inflating from 1989 to 1991 prices at 4.5% per year.

18. The equivalent standard axle load of a candidate vehicle or axle is defined as the number of passes of a "standard axle load," of 18,000 lb. (8 163 kilograms) on a single axle supported by four tires, required to create the same amount of damage as one pass of the candidate axle load. In customary form ESALs have been calculated from the "fourth-power law" of pavement damage. See Nix et al., "Road Costs," subsection 2.3.3.

19. See subsection 5.1.2. for the derivation of capital costs for cars. Allocating 40% to 60% of the total highway capital stock of $59 billion to highways, and 25% (by PCE-kilometres) to heavy trucks, applying an annual capital charge of 10%, and averaging over 16 billion vehicle-kilometres gives 3.7¢ to 5.5¢/veh-km.

20. F.P. Nix, *Road-User Costs*, Report TP 9766 (Ottawa: Transport Canada, April 1989).

21. As noted in the report by Nix et al., "Road Costs," use of the cost formula with "Waterloo Load Equivalency Factors" instead of ESALs would raise the estimated cost per vehicle-kilometre by some 40% to 50%.

22. It should be noted that the estimates of what are referred to as "marginal pavement costs" in the report by Nix et al. are not directly comparable, either in units of measurement or in concept, with the conventional definition of marginal cost of pavement wear. The latter refers to the cost of wear associated with passage over the pavement of one truck. The report investigated the way in which capital construction costs plus the present discounted value of resurfacing costs over the life of the highway vary with traffic volume, including volume of heavy truck traffic, assuming road and pavement structure are optimal given the traffic volumes. Thus, the report's "marginal pavement cost" represents the estimated increase in discounted life-cycle investment expenditures (a capital stock concept not an annual cost) as the average annual traffic volume increases. Further, the report does not directly address the issue of estimating truck wear on existing highways that may not be optimally matched to traffic volume.

23. Sypher : Mueller International Inc., *Air Infrastructure Costing*, a report prepared for the Royal Commission on National Passenger Transportation, RR-04, August 1991.

24. For the eight largest sites (Dorval and Mirabel are considered as one) or major federal airports (MFAs), which were part of the now discontinued Airports Revolving Fund, financial statements are produced on an annual basis, which conforms to generally accepted accounting principles. The statements are contained in a publicly available document produced each year by Transport Canada entitled "TP 1300 Airports Revolving Fund, Financial Statements for the year ended 19_ _".

    For the next 14 largest sites, which were once part of the Airport Revolving Fund and are now known as federally dependant airports (FDAs), annual financial statements are produced by the site financial officers and submitted to the Financial Advisor of the Airports Group at headquarters. Although these statements are not published or audited like the MFA sites, copies can be obtained through headquarters personnel and represent a reasonably accurate source of site costs and infrastructure.

    For the remaining sites, which are also classified as FDAs, financial statements are not prepared on an annual basis and are only available on a timely basis when Transport Canada undertakes special studies to update the Department's historical financial data base. A complete update of this data base was last undertaken for the fiscal year 1987-88.

25. Costs have been allocated to three user groups — commercial, instrument flight rules (IFR) general aviation (ga), and visual flight rules (VFR) ga. Commercial includes unit toll, charter, and other commercial operations. Unit toll is defined as the transport of people or goods on a toll or price per person or unit. Charter is the transport of a person or good for a price to hire the aircraft per kilometre or hour. Other commercial operations include flights performed by commercial aircraft other than the unit toll or charter services. IFR ga includes itinerant movements of operators using radio navigation instruments to assist the pilot. VFR ga includes itinerant and all local movements of operators not using radio navigation instruments. In general terms, IFR ga tends to use larger, more sophisticated aircraft, while VFR ga tends to use smaller aircraft.

26. See D. Gillen and T. H. Oum, "Transportation Infrastructure Policy: Pricing, Investment and Cost Recovery," in Volume 3 of this report.

27. No readily accessible source of data was available for the replacement cost of Transport Canada's fixed assets; however, historical book value and accumulated depreciation were available on a site-specific basis.

    To develop a reasonable proxy for capital charges based on replacement value for each site the accumulated depreciation was divided by the average annual depreciation expense to estimate the average life of the asset base. From this, an average original year of expenditure for the base was calculated. This original year was then used to determine

the cost-escalation factor based on the Statistics Canada's Implicit Price Index for Total Construction, which was applied to the original book value to restate it in terms of 1990–91 dollars. If the asset base increased by more than 20% in any one year, the amount of the expenditure was removed from the cost base and inflated by the factor that corresponded to the year of the expenditure.

28. Transport Canada, *1989–90 Estimates: Part III, Expenditure Plan* (Ottawa: Supply and Services Canada, 1989).

29. On a movement allocation basis, this would be: 4 movements at $42.54 + 3 500 kilometres at $0.15 = $695. Divided among a typical 85 passengers, this amounts to $8 per passenger.

30. Charles Schwier and Richard Lake, "VIA Rail Services: Economic Analysis," in Volume 4 of this report.

31. Statistics Canada, *Rail in Canada, 1989*, Catalogue No. 52-216, 1991.

32. Transport Canada, *Proposed New Cost Recovery Policy: Phase II Discussion Paper*, Report TP 10041 (Ottawa: April 1990), Table 14, updated with values for fiscal year 1990–91 by personal communication from Economic Evaluation and Cost Recovery Directorate, Transport Canada.

33. Most of the estimates of the willingness-to-pay for risk reductions are expressed as values per death avoided, when the risk reductions involve reductions in both deaths and injuries. It is not then appropriate to add to the material losses from injuries a further value for willingness-to-pay to avoid emotional losses through injury. The value of the material losses is therefore used for injured victims, $10,000 per victim.

34. Only in a minority of accident cases is there a court determination of compensation. Other cases settled out of court might include compensation for emotional losses, and in a larger number there is some nominal payment based on the insurance contract. Compensation in all such cases is unlikely to be as great as the cost inferred from the willingness of users to pay for risk reductions.

35. Pilorusso Research & Consulting Inc., *The Cost of Inter-City Travel*.

36. Statistics Canada, *Passenger Bus and Urban Transit Statistics, 1989*, Catalogue No. 53-215, 1992.

37. Tax rates in 1992 for intercity buses are, for example, $522 for a bus with a gross weight as high as 20 000 kilograms in Ontario, and $522 in Saskatchewan for any bus with more than 25 seats.

38. Richard Lake, L. Ross Jacobs and S. T. Byerley, "An Analysis of the Canadian Intercity Scheduled Bus Industry," in Volume 4 of this report.

39. The Canadian bus industry records its data in imperial units.

40. Airline Cost Information Sources

Aviation Planning Associates, *Analysis of Elements of Direct Operating Costs of Canadian Air Carrier Jet Aircraft* (Canadian Transport Commission, Research Branch, 1983).

Aviation Planning Associates, *Direct Operating Costs Comparison of DHC-7 and DHC-8 with Competitive Aircraft* (Canadian Transport Commission, Research Branch, 1982).

M.A. Bajwa, *Direct Operating Cost Comparison of DHC-7 & Competitive Aircraft* (Canadian Transport Commission, Research Branch, 1974).

M.A. Bajwa and G. Shurson, *A Study of Mainline and Regional Air Carriers' Terminal Handling Costs* (Canadian Transport Commission, Research Branch, 1981).

M.A. Bajwa and G. Wilson, *An Analysis of Canadian Air Carriers' Operating Costs* (Canadian Transport Commission, Systems Analysis Branch, 1974).

CTC Research, *Inflation and the Canadian Airline Industry* (Canadian Transport Commission, Research Branch, 1984).

R. Fosbrooke, *A Study of the Incidence of Cross-Subsidy in the Canadian Airline Industry* (Canadian Transport Commission, Research Branch, 1980).

J. Gibberd, *Airline Costing: An Introduction* (Canadian Transport Commission, Research Branch, 1985).

J.A. Greig, *The Low-Priced Air Fare Review: The First Five Years* (Canadian Transport Commission, Research Branch, 1983).

J. Greig, and R. Fosbrooke, *Nature of Operating Costs, in Study of Competition in the Canadian Airline Industry: Cost Structure* (Canadian Transport Commission, Research Branch, 1979).

D.B. Laprade, *The Basic Economics of Air Carrier Operations* (Canadian Transport Commission, Research Branch, 1981).

J.C. Moloney, *Air Canada's Domestic Economy Fare Formula and Its Relationship to Average Domestic Scheduled Costs* (Canadian Transport Commission, Research Branch, 1986).

R. Roy, *Economies of Scale in the Airline Industry* (Canadian Transport Commission, Research Branch, 1980).

Roger Roy and Diane Cofsky, *A Productivity Study of Canadian Air Carriers* (Canadian Transport Commission, Research Branch, 1984).

R. Roy, and R. Fosbrooke, *Joint and Common Costs for Major Carriers, in Study of Competition in the Canadian Airline Industry: Cost Structure* (Canadian Transport Commission, Research Branch, 1979).

41. For the purpose of this analysis, an airplane (or seat or passenger) stage is defined as a take off and a landing. A flight may involve additional takeoffs and landings (intermediate stops) but with a single flight coupon and not normally a change of airplane. A trip may include multiple flights but is not broken for purposes other than onward connections.

42. Statistics Canada Catalogue No, 51-005, 51-204 and 51-206 for 1988, 1989 and 1990; Air Canada and PWA Corporation Annual Reports for 1988, 1989, 1990 and 1991 (PWA only).

43. This is a more restrictive definition than that used to estimate the cost of an average domestic trip later in this section. Any change of airline, even to an affiliated carrier, or from domestic to international flights, is counted as an additional passenger trip in the Statistics Canada data, which was partially used to develop this model.

44. As these data were quite uncertain, given the variety of sources, a variant of the model to test the sensitivity of the unit cost estimates to these parameters — particularly the number of flights in the average trip — was run. An assumption of 1.35 flights per trip — more than doubling the assumed proportion of multi-flight trips — resulted in increases in estimated vehicle/carrier cost for the sample routes that ranged from 2.5% for Saskatoon–Halifax to 6.5% for Toronto-Montreal. In the context of the Royal Commission's analyses, this is not significant.

45. The pass-km and stage-km elements of the cost would be more accurately computed using the actual load factors for the stages involved, if these were known. For the present purpose — portrayal of typical cost — the system average Level 1 figure is more appropriate.

46. Inflated from data presented in S. A. Morrison, "Deregulation and Competition in the Canadian Airline Industry," in Volume 4 of this report.

47. As was shown in Table 3(2)-8, combined federal and provincial aviation turbo fuel taxes net of provincial sales tax vary from 0.6¢/L in Newfoundland and 1.3¢/L in Nova Scotia to 9.1¢/L in Saskatchewan. A system-average special tax/fee rate of 5.8¢/L was calculated as a weighted average of consumption of aviation turbo throughout the country. Inasmuch as the system average is calculated for all aviation consumption, it may not be entirely accurate for domestic, as opposed to international, services. A greater source of uncertainty applies to the route-specific estimates. These are based on the assumption that the quantity of fuel consumed during each stage travelled is taxed in the jurisdiction where that stage commences. In the case of Halifax–St John's, the assumed special tax/fee shown is therefore very low, and the tax for a seat-stage taking off from Saskatoon has been assumed to be high. Of course, aircraft do not always take on fuel before every takeoff, or in the exact quantity to be consumed during the succeeding stage. Subject to overriding safety considerations, airlines manage their fuel acquisition to minimize their costs of operation, of which fuel cost — including taxes — is an important element.

48. Charles Schwier and Richard Lake, "VIA Rail Services: Economic Analysis," in Volume 4 of this report. (See Section 3, Rail Passenger Cost Model and Appendices A, B and C.)

49. Capital charges include depreciation and a 10% cost of capital, and assume that all assets are 50% depreciated.

50. Geoplan Consultants Inc., Canadian Ferry Costs and Industry Analysis, a report prepared for the Royal Commission on National Passenger Transportation, RR-09, December 1991.

51. Ibid., costs from Tables 5.1 and 5.2, and revenues from Tables 6.1 and 6.2.

52. The total costs concerned would be too small to have other than a negligible effect on estimated average costs.

53. Geoplan, Canadian Ferry Costs, Table 8.1.

54. The Research and Traffic Group, The Great Lakes and St. Lawrence Seaway System: Commercial Attractiveness and Priorities for Policy Development, report prepared for the Marine Office, Ontario Ministry of Transportation, 1990.

55. Geoplan Consultants Inc., Marine Atlantic Background Information 1988–1990, a working paper prepared for the Royal Commission on National Passenger Transportation, 1991.

56. Geoplan, Canadian Ferry Costs, Tables 4.3 and 3.2, respectively.

57. Ibid.

Annex 1: Opportunity Cost of Highway Land

An attempt is made here to estimate the amount of land occupied by the highway network, and its opportunity cost, in terms of value in reasonable alternative use.

ROUTE-KILOMETRES BY PROVINCE

The lengths of highways are obtained from the annual statistical publication of the Transportation Association of Canada.[1] The estimated route-lengths by province are shown in Table 3(2)-A1, and total 8 220 km of expressway and 129 016 km of paved rural highway.

AREA OF LAND DEDICATED TO HIGHWAYS

The width of land used for expressways varies substantially depending on the nature of the terrain and surrounding land use, as well as the number of lanes, widths of medians, shoulders, and so on. It is assumed for simplicity that the average width of the right-of-way for conventional four-lane rural expressways is 100 m. This is believed generous — leading again to a possible slight over-estimate of land use. For two-lane rural highways, the standard width of right-of-way is 100 feet (30.5 m).

A simple calculation then allows an estimate of the total area of land taken by expressways as 82 000 hectares, and of that occupied by rural highways as 393 000 hectares, for a total of 475 000 hectares. Provincial estimates are also shown in Table 3(2)-A1.

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1. In recent years, for example, Transportation Association of Canada, *Highways in Canada: 1991 Report*, (Ottawa: TAC, 1991), these figures have been presented only in "equivalent two-lane kilometres," but estimates of the route-kilometres are possible by reference to the publication for 1985, Roads and Transportation Association of Canada, *Roadway Infrastructure Study* (Ottawa: RTAC, 1987). For "paved rural roads" it is reasonable to assume that two-lane kilometres are identical to route-kilometre, as the 1985 publication showed the former to be less than 2% greater than the latter (and this assumption will therefore produce a very slight over-estimate of land costs). For expressways, the adjustment is more important, as the difference between two-lane kilometre and route-kilometre is shown by the 1985 publication to be large, and to differ substantially by province. The particular assumption made here is that the average freeway is four lanes, with the exceptions of Quebec and Nova Scotia, for which the 1985 publication showed that the expressways had fewer lanes than the national average. It has been assumed for both provinces that the 1985 highways still exist, and that all expressway-kilometres added since that date have been of four-lane standard.

Table 3(2)-A1
AREA AND VALUE OF LAND USED FOR PROVINCIAL EXPRESSWAYS AND HIGHWAYS, 1990

	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	Nfld.	All provinces
Expressways:											
– route-km	427	1,232	24	0	1,882	3,200	110	1,300	0	45	8,220
– rural hectares	4,227	12,197	238	0	18,632	31,680	1,089	12,870	0	446	81,378
– urban hectares	43	123	2	0	188	320	11	130	0	5	822
Other highways:											
– route-km	20,554	12,907	10,299	6,878	16,419	36,245	4,400	11,804	3,408	6,102	129,016
– rural hectares	62,022	38,947	31,077	20,755	49,545	109,370	13,277	35,619	10,284	18,413	389,308
– urban hectares	626	393	314	210	500	1,105	134	360	104	186	3,932
All highways:											
– rural hectares	66,249	51,144	31,315	20,755	68,176	141,050	14,366	48,489	10,284	18,858	470,686
– urban hectares	669	517	316	210	689	1,425	145	490	104	190	4,754
– total hectares	66,919	51,661	31,631	20,964	68,865	142,475	14,511	48,979	10,388	19,049	475,441
Rural value/hectare ($)	1,198	788	516	642	2,644	1,053	808	872	1,453	1,527	1,223
Urban land value/ hectare ($)	370,645	370,645	370,645	370,645	370,645	370,645	370,645	370,645	370,645	370,645	370,645
(i) Value of total hectares as farmland ($M)	80	41	16	13	182	150	12	43	15	29	581
(ii) Value of rural hectares as farmland, and urban hectares for housing ($M)	327	232	133	91	435	677	65	224	53	99	2,338

OPPORTUNITY COST OF THE LAND

In attempting to identify this opportunity cost, it is tempting to look at the market prices commanded by equivalent land close by. But this is subject to a conceptual criticism: surrounding land use can be substantially altered by the existence of the highway. In general, the accessibility provided by the highway generates more surrounding activity than otherwise, and raises the market value of the surrounding land.

For the rural land used for highways in Canada, this concern is probably not of practical importance. One can probably simply look to the use of the land prior to the highway being built, or consider what the use would revert to if the highway were scrapped, and come to a similar conclusion about the realistic opportunity costs. If there were only local access (through the grid road system), the land would probably be usable only for some form of agriculture or forestry, or might not be suitable for either and remain unused. No information is available to estimate which portions of Canadian highways would revert to each of these purposes, nor are details available of actual land prices by location, from which it might be possible to estimate values of land used for specific highways. The average prices of farmland by province, however, are available, and are shown in Table 3(2)-A1.[2] Such averages are province-wide, and might represent land on average that is even more remote from settlements than the land used for highways. On the other hand, these prices are for the portions of land that are usable for farming, when much of the land on which highways are constructed would likely otherwise be too poor for farming, and worth even less. These prices for farmland can be used as an indication of the alternative value of land used for highways, in the expectation that they probably overestimate the true opportunity costs.

The complexity is greater for urban land occupied by highways. Accessibility increases the value of the adjacent land. Therefore the

2.   Personal communication from Agriculture Division, Statistics Canada, February 1992.

opportunity cost of the highway land should not be represented by the market value of adjacent land, but more reasonably by that of equivalent land that does not have the accessibility advantage from the highway. It could be difficult, if not impossible, to identify such "equivalent land," without some other accessibility advantage. Again, the logical test might be the value that the land could command if the highway were entirely abandoned. It seems reasonable to assume that the land would otherwise be served simply by local access streets, and be usable for residential or commercial purposes comparable with land similarly served in the community concerned.

For illustrative purposes, it is assumed that the alternative use would be for residential purposes, with value equal to the average price of land for new house construction for the entire cities concerned (therefore reflecting the total accessibility advantages gained from the communities' transport connections, but with no premium from direct proximity to any particular connection).

Estimates of average new detached/semi-detached house prices in 1991 were obtained from Canada Mortgage and Housing Corporation (CMHC).[3] The appropriate national average of residential land prices is elusive, as CMHC does not provide estimates of new house prices for all of the communities on the national network. Instead, one can only guess at the relevant price from the averages for those larger communities that are provided. These show that the average new house price in 1991 among the 25 largest metropolitan areas was $197,000, of which approximately 30% is the land component, or about $59,000. Among the 52 largest communities, the value was $149,000, and the land component[4] at 30% amounted to approximately $50,000. These communities feature prominently in the primary highway network, but so do a much larger number of smaller communities.

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3. In personal communications between Royal Commission staff and staff from Statistics Division of CMHC, Feb. 27,1992.

4. Information provided by Statistics Canada and CMHC by city suggests that the land proportion of the total house price is surprisingly constant at nearly 30%, when total prices ranged between $109,000 and $305,000 among the cities covered. As the information is compiled from reports made by builders, it is possible that they are using a simple rule-of-thumb of 30% in their responses.

Furthermore, those land values are for serviced land and for detached houses. The average value for urban land occupied by highways is probably therefore substantially lower. For illustration, an average value is assumed of $30,000 for a lot of 4,000 square feet (370 m²). With five lots per acre (or, more than 12 per hectare), allowing for services, this suggests values of unserviced land of about $150,000 per acre, or $371,000 per hectare, in 1990 prices.

The area of urban land involved is not large as a proportion of total land used for highways, but, as will become obvious in the examples that follow, the precise amount and its value is crucial to the estimate of the total value of the land used. No record is available of the length of the urban portions of the highway system; that is, those portions that, in the costing scheme, are assumed to displace residential land rather than farmland. It seems certain that the proportion cannot be as much as 5% (1 km in 20, or 7 000 km of the entire 140 000 km of primary highways being in urban areas), and more likely is closer to 1% (1 km in 100, or 1 400 km in total). A proportion of 1% of the highway system will represent urban portions.

RESULTS OF ALTERNATIVE ESTIMATES

Alternative Value as Farmland

Table 3(2)-A1 shows the value that the road network would have if the only alternative use of the entire system was as farmland. Using the average farmland prices provided by Statistics Canada, the 82 200 hectares of expressways would be worth $111 million, and the 393 000 hectares of 2-lane highway would be worth $470 million, giving a total for the whole system of $581 million.

Alternative Rural Value as Farmland, Urban Value for Housing

Table 3(2)-A1 also shows estimates for the opportunity costs of the land if 99% of it is rural, usable for farming, and the other 1% is in urban areas, usable for residential development. The essential assumptions from above are:

- Expressway right-of-way width   100 metres
- Paved 2-lane highway right-of-way width   100 feet
- Proportion of all highways in urban areas   1%
- Average price of urban residential land per
  unserviced hectare $370,000

The urban portions of the highway network have an estimated value of $1.8 billion. The total value of the urban and rural systems is now estimated at $2.4 billion. The importance of the assumptions about the area and value of the urban portions can be appreciated, as the rural part of the network, while 99% of the total length of the system, has an alternative value at farmland prices of $570 million, only 24% of the total value.

It is judged that this latter estimate, including urban land valued by its potential alternative development, is more appropriate than valuing the entire land as farmland. The estimate is therefore converted to a cost per passenger-kilometre, as follows.

Estimated Opportunity Cost of Land per Passenger-Kilometre

In order to compute these land costs per unit of traffic, the capital value of the land is converted into an annual sum, using a real rate of 10% per year as the opportunity cost rate.

Land costs are then allocated between private passenger and other vehicles according to the number of "passenger-car-equivalent-kilometres" they contribute annually. As noted earlier, this procedure allocates some 70% of costs to cars/light trucks in passenger use.

Also as noted earlier, annual traffic on the highway network by cars and light trucks in passenger use is estimated as 120 billion vehicle-kilometres, and 210 billion passenger-kilometres.

The results of the computations are as follows:

Total capital cost of land	$2,400 million
Annualized cost at 10%	$240 million per year
Annualized cost attributable to cars	$170 million per year
Cost per passenger-kilometre	$0.0008

In conclusion, using the base-case assumptions, the total land value is estimated as approximately $2.4 billion, which, when annualized at real interest rate of 10% in perpetuity produces a value of approximately 0.08¢/pass-km. Given the uncertainty in this estimate, it is incorporated in the highway infrastructure cost estimates, rounded to 0.1¢/pass-km.

ANNEX 2: OPPORTUNITY COST OF AIRPORT LAND

The dimensions of the nine major federal airports, together with the latest appraisals (by purpose) of the land available at each of the sites, were made available by Transport Canada,[1] and are shown in Table 3(2)-A2. The appraised values are for actual parcels of land on the airport property available for the specified uses. Objective appraisers (usually Public Works Canada) rate the property based on its characteristics and comparisons with land used for similar purposes in the immediate area.

Table 3(2)-A2
APPRAISED VALUE OF LAND AT MAJOR FEDERAL AIRPORTS, 1991, BY PURPOSE

	Size	Value appraised per square metre, by type of use					
		Light industrial with air-side access	Light industrial	Commer-cial	Heavy industrial with air-side access	Heavy industrial	Agri-cultural
	(hectares)	($)	($)	($)	($)	($)	($ per hectare)
Halifax	951	30	—	36	—	17	(870)[a]
Mirabel	6,920	28–35	23–28	32–82	12–24	10–20	1,400
Dorval	1,668	75	45	100	—	25	—
Pearson	1,715	—	68–79	124	—	50	—
Ottawa	2,086	—	78–90	100–120	—	40	—
Winnipeg	1,504	35	—	40	—	30	—
Edmonton	2,800	21	—	—	—	20	2,700
Calgary	1,839	43	—	50	—	38	—
Vancouver	2,800[b]	—	86–109	—	—	—	—

a.   Appraised value not provided by Transport Canada, so instead the figure is the average value for farmland in Nova Scotia estimated by Statistics Canada, Agriculture Division.
b.   1 000 hectares assumed available for alternative development, to preserve wetland.

It can be seen that land for "commercial" purposes has the highest value: this would be land with excellent access — probably on an arterial road — with potential for development of shops, hotels, and so on. It is therefore a very limited proportion of the land on any

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1.   Personal communication between Royal Commission staff and staff of Transport Canada Airports Group, March 1992.

airport site, and its appraised value is probably dependent on the traffic attracted by the airport. As such, it is inappropriate as a measure of the opportunity cost of the airport land, that is, value in alternative use if the airport were not there.

The light and heavy industrial land designated as "with air-side access" is close enough, and on direct roadways to the air-side land, so that it could be used for services for the airlines and aircraft. ("Light industrial" use would include hangars, flight kitchens, fuelling, de-icing; "heavy industrial" use would be rare, including, for example, oil tank farms.) Such land therefore has a premium value over industrial land without air-side access, which can presumably be used only for the same purposes as equivalent land outside of the airport. The appraised value of this land without air-side access therefore gives an indication of the value of the land in industrial use if the airport were not there.

The appraised values of land for agricultural use are clearly much lower than values for the other purposes. Much airport land is apparently usable for farming, and large parts of some airports are currently leased for it — particularly Edmonton, but with sizeable portions also of Calgary and Winnipeg airports.

The appraised values do not include residential use as a current option, but it should be considered in seeking the opportunity cost of the land. Abandonment of the airports (or shifting them to more remote locations) could make available large tracts of land close enough to the centres of some cities that they would be attractive for residential purposes. Even though some of the sites are surrounded by light industrial or heavy-industrial activities, they are sufficiently large that they could be developed as residential enclaves.

In fact, they could become very large residential developments. Table 3(2)-A3 shows the number of houses that could be built on some of the airports, if there were only about 12 houses to the hectare (five to the acre) — which assumes only about half the available land would be house-lots, with the rest used for services, institutions, and so on.

About 20,000 houses could be built on the land area of each of Dorval, Pearson or Calgary airports, about 25,000 on Ottawa's site, or about 35,000 on that in Vancouver. Table 3(2)-A3 also shows the value of this land at the average price estimated for the relevant cities (estimated as described earlier for the value of highway land, assuming serviced land accounts for 30% of new house prices, obtained from Canada Mortgage and Housing Corporation).

Table 3(2)-A3
VALUE OF AIRPORTS IF DEVELOPED FOR RESIDENTIAL USE, 1991

	Number of houses at 12 per hectare (approx)	Value of residential land ($ per hectare)[a]
Dorval	20,000	300,000
Pearson	20,000	900,000
Ottawa	25,000	400,000
Calgary	22,000	500,000
Vancouver	32,000[b]	700,000

a. Based on estimated values per serviced lot provided for cities from Canada Mortgage and Housing Corporation; reduced by $10,000 per lot as a rough allowance for servicing.
b. Only 1 000 hectares assumed available for development.

If entirely used for residential development, the areas of Pearson and Calgary airports would apparently be worth more than for light industrial use, at about $1.5 billion and $0.9 billion respectively. The sites at Ottawa ($0.8 billion), Vancouver ($0.7 billion) and, in particular Dorval ($0.5 billion) would, by these simplistic calculations, apparently be worth less in residential than in light industrial use.

It should be noted also that these developments would be so large that they would certainly affect the price of housing, and residential land, even in the three largest cities. They might be impractically large, depressing prices so much that the development would only be viable if spread over many years. In cities of the size of Ottawa or Calgary it would certainly not be viable to add so much housing in the short term (25,000 houses would probably add 15% to 25% to the total number existing in Ottawa). Therefore it is probably unreasonable to assume residential development as the opportunity use of the entire area of any of the major federal airports.

For illustrative purposes, Table 3(2)-A4 shows the hypothetical value of the area of each of the airports in possible alternative use. The estimates are very rough, given the uncertainties in the estimated average values per unit of land by purpose, and particularly the reasoning on alternative uses. The reasoning is as follows:

• The sites at Halifax, Mirabel and Edmonton are sufficiently distant from other centres of activity that the possibility of attracting industrial or commercial activity to fill their sites is remote, and farming seems the more reasonable option (and even that might be optimistic for Halifax, or for the entire site of Mirabel).

• For the other airports, it seems likely that some portion of the land could find alternative light industrial use. For Ottawa, Winnipeg and Calgary, the airport areas would add so much land to that available for light industrial use within those cities that it would be very unlikely that the whole area would be developed. There is substantial land available of similar quality, at similar distances from the city centres in each of those communities. It is assumed that 25% of the areas of these airports could be sold at the current price for light industrial land (or, more precisely, that at each of the sites a value equivalent to the current price multiplied by 25% of the surface area could be realized if an attempt to sell the entire area was made).

• For Dorval and Vancouver it is assumed that land so accessible to the city is in sufficient demand that most or all of their usable surface could be turned to light industrial use. The amount of land concerned would still be a significant addition to total light industrial land available even in those regions, so it can be expected that making these tracts available would lower the market price, to some extent. To allow for the interaction of the amount available and its price, it is assumed that the maximum value obtainable from these sites is 50% of their surface area[2] multiplied by the current price — representing, for example, being able to find buyers for 50% of the area at current prices, or lowering the price by 50% in selling the entire space immediately.

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2.   It is also assumed that only 1 000 hectares of the Vancouver site would be available for development, the remainder being conserved.

- For Pearson, it is assumed that the alternative use is residential, and that a value equivalent to 50% of the current lot price could be realized if the entire surface area was sold.

Table 3(2)-A4
OPPORTUNITY COSTS OF LAND AT MAJOR AIRPORTS, 1991

Airport	Estimated land values ($ millions)
Halifax	1
Mirabel	10
Dorval	400
Pearson	750
Ottawa	440
Winnipeg	130
Edmonton	8
Calgary	200
Vancouver	500
Total (rounded)	2,500

Value of Land at Other Airports

Transport Canada has also provided the surface areas of another 87 airports (without any information on their appraised values). The land used for many minor airports has little opportunity cost, in that equivalent unused land is available close to many of the cities and towns concerned. On the other hand, similar land, close to the larger centres, could be very valuable in alternative use. To represent the possibilities, without any site-specific information, it has been assumed for the 20 next-most-important airports, comprising "Class III" in the study for the Royal Commission of airport costing,[3] that the average value of the land at these sites is half the average for the seven Class II major federal airports (that is, the nine airports in Table 3(2)-A4 except Pearson and Vancouver, which form Class I). From the above analysis, the average value per hectare for those seven was $67,000. The average assumed for the next 20 is therefore $33,500 per hectare. Their total area is 12 319 hectares, so the total is $411 million. Added to the median value of the nine major airports, the total then becomes $2.9 billion.

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3. Sypher : Mueller International Inc., *Air Infrastructure Costing*, a report prepared for the Royal Commission on National Passenger Transportation, RR-04, August 1991.

For all remaining airports, the value of the land is assumed to be negligible (especially given the margin of error in the above estimate).

Annualized Value of the Land

The total capital value estimated above is about $2.9 billion. Using a real rate of 10% per year as the opportunity cost rate for capital assets, this land cost is estimated at $290 million per year.

Land Value per Passenger-Trip, and Passenger-Kilometre

Averaged over a total of 62,813,444 enplaned/deplaned (E/D) passengers at all airports in 1988, the total land value would then amount to some $4.60 per passenger. For the illustrative costs in 1991, this is rounded up to $5 per E/D passenger, or $10 per stage. Averaged over the representative air trip of 1 478 km with 1.6 stages, it amounts to 1.08¢/pass-km, included in the system-wide average costs as 1¢/pass-km.

NOTES TO CHAPTER 6:
RAIL INFRASTRUCTURE ISSUES

1. Running Rights and Joint Track Usage

This section provides a more extended discussion of existing arrangements under which one railway company uses another railway company's track, as a supplement to the subsection of Chapter 6 in Volume 1 entitled "Improving Access to Rail Tracks."

1.1 GENERAL

Running rights and joint operations have a long history both in Canada and elsewhere, and are considered by some to be residual customs from early railway development in England. Today, sharing sections of track owned by another railway company is both common and beneficial. Running rights and joint operations not only provide railway companies with access to another company's lines, but can also provide alternative transportation services for railway customers. In Canada, with its difficult geography, such alternatives are very important — when a railway's track is temporarily closed through accident or for major maintenance, trains are routinely routed over a competitor's line.

In some instances, the sharing of facilities is brought about by the need to connect two pieces of track. At the root of this sharing is a desire to avoid unnecessary duplication of railway facilities. Running rights can permit a railway company without its own track to operate successfully. Although it does have small track holdings, VIA Rail essentially operates in this way.

There is a technical difference between running rights and joint operations (or joint track usage). A railway company may have the right to operate trains over the tracks of another railway without any reciprocal (running rights) privilege for the second railway. Joint operations (joint track usage) involve railways sharing facilities in order to improve service or to avoid the duplication of facilities. In Canada, situations range from the example of one railway operating trains for a few hundred feet using another's tracks in order to connect

to its own track (running rights), to the proposal that CN and CP jointly use track in the Fraser River canyon. This proposal was made (but never implemented) 10 years ago[1] when double digit traffic growth was forecast.

Running rights and joint track usage complicate the technical operation of a railway. This is most obvious where freight and passenger services are combined. The problem is largely one of operating logic (and perhaps union agreements, where crews are paid on the basis of distance rather than time). Passenger trains accelerate faster and generally operate at faster speeds than freight trains. Also they are usually given higher priority. Problems with scheduling and signalling, especially road crossing protection, can be encountered.

In Canada at the moment, perhaps the most complex operational situation exists between Hamilton and Toronto, where one double-track line serves CN, CP, VIA Rail and GO Transit. This example falls somewhere between the simple running rights example and the Fraser River canyon example, and could be considered joint operations, since the construction of duplicate facilities has been avoided.

1.2 LEGISLATION AND REGULATION

1.2.1 Canada

Legislation concerning access to trackage of another company has been in the *Railway Act* for many years[2] and remained largely unchanged from the 1919 Act until the proclamation of the *National Transportation Act, 1987* (NTA, 1987).[3] When the NTA, 1987 was drafted, most of the provisions concerning the use of facilities belonging to another railway were taken from the *Railway Act* (section 134) and placed in Part III, Division I of the NTA, 1987, which only deals with freight (see Annex 1). Previously, section 134 of the *Railway Act* had applied to both freight and passenger rail; however, section 94 of the *Railway Act* (1970) remains intact (renumbered section 98) and provides for running rights or joint track usage if the directors of the respective companies agree.[4] The regulatory body's

power to order a railway to permit a passenger operator on its lines appears to have been removed, since section 98 (formerly 94) merely provides for agreement by the respective carriers.

The NTA, 1987, section 148 provides for mandatory running rights. Reviewing how it has been applied (for freight) is instructive. The National Transportation Agency recently granted an organization that owns no track (known as MOQ Rail[5]) the status of a railway company under section 11 of the *Railway Act* as amended in 1987. The requirement for this status is similar to that for freight motor vehicle undertakings — a certification of fitness. In May 1990, MOQ Rail applied to operate under the provisions of the NTA, 1987, section 148, over CN lines between Moncton, New Brunswick, and Windsor, Ontario. Tests for a prototype operation (prior to certification under the *Railway Safety Act*) were planned; however, MOQ's application was withdrawn when CN purchased 50% of the company.

1.2.2 United States

In the United States, if Amtrak can demonstrate the need to operate over a section of line and can demonstrate that the line is inadequate for passenger operations, the Interstate Commerce Commission (ICC) can require the owning railroad to sell the line to Amtrak for an amount set by the ICC under the provisions of the *Rail Passenger Services Act of 1970* (45 USC 562(d)). As of early 1992, a case was pending before the U.S. Supreme Court that challenged the ICC's enforced sale to Amtrak of a line owned by Guildford Transportation, which owns and operates the Boston and Maine and the Maine Central Railroads. In this instance, Amtrak upgraded the line and then sold it to one of Guildford's competitors.

When Amtrak was established, several lines in the northeastern United States were conveyed to it, while in other areas, it operated over shared facilities. For example, Amtrak at one time operated through the Detroit to Windsor tunnel without paying for the use of the facilities and ran over the Canada Southern (then controlled by

ConRail) across southern Ontario to Niagara Falls. It picked up and carried Canadian passengers between Canadian points and did not pay for the use of the Canada Southern line. It neither sought nor received formal authority from the Canadian Transport Commission to operate on that route. Furthermore, the tunnel was a subsidiary of the Canada Southern, a Canadian company. Amtrak subsequently terminated the service and CP and CN purchased the Canada Southern, the tunnel and the railway bridge at Niagara Falls.

With respect to freight operations in the United States, the ICC has often ordered joint facility usage, especially in yards, when mergers have taken place. Running rights and access to yard facilities have been ordered to ensure that a railroad can connect its various segments of track, and that it can reach connecting carriers.

1.3 COMPENSATION

Canadian statutes are silent on the matter of compensation. There are several accepted methods of compensating a railway for the use of its facilities, and these are largely determined by the type of usage made and the privileges accorded to the user railway. There does not appear to be any impediment to two parties developing their own method of compensation based on the nature of the agreement.

In the simplest example — of using a very short stretch of track — the compensation normally consists of installing and paying for the connection(s) and sharing the maintenance costs of the short section of track. In other circumstances, if the host railway only permits the user to run over its line without picking up or delivering freight or passenger traffic, compensation normally consists of what is known as wheelage — that is, a fixed amount per car or locomotive that runs over the line. If the user is allowed to solicit business along the host line, compensation may be a percentage of the revenue generated by the user railway (for example, CP's arrangements for running over CN lines between Port Colborne and Welland).

2. Benefits and Costs of Greater Specialization in Track Use for Freight and Passenger Services on the Toronto–Ottawa–Montreal Track Network — A Preliminary Analysis

The subsection of Chapter 6 in Volume 1 entitled "Should a Separate Rail Track Agency be Public or Private?" notes the possibility of rationalizing track use in the Toronto–Ottawa–Montreal triangle. Chapter 18 notes that faster service on some passenger rail routes might be an element of development of some viable rail services. One suggestion presented to the Royal Commission was that dedicating one of the existing Toronto to Montreal rail lines to passenger rail might allow significant improvements in train speed, especially if accompanied by some track upgrading. The Royal Commission did not attempt any thorough evaluation of this suggestion — such an evaluation is the task of managers of passenger rail operations who, under the Royal Commission's framework, would have the main responsibility for judging whether such initiatives might be commercially viable. Some preliminary analysis, however, was carried out that may be of interest to those concerned with passenger rail possibilities.

This note considers the potential for the three class-1 railways — CN, CP and VIA Rail — to reorganize their infrastructure to deliver better rail services, and to do so more efficiently, through consolidating freight operations on one of the main line systems and dedicating the other to passenger service or, more likely, optimizing it to the requirements of passenger service. Any such change would require line upgrading and there could also be regulatory requirements to overcome.

2.1 GENERAL CONCEPT

Achieving a substantial degree of specialization of the intercity track in the Toronto–Ottawa–Montreal triangle in either freight or passenger operations might require a single track authority. This note, however, does not concern itself with such possible institutional

reform, but rather explores cost aspects of greater specialization in track use that would be relevant whatever the institutional arrangements.

From the passenger service point of view, potential benefits would arise out of:

(a) redistribution of the freight traffic on the existing lines so as to provide one Toronto to Montreal route that could be "optimized" for intermediate speed passenger operations; and

(b) any further arrangements that would help minimize the extent to which competing freight and passenger traffic were at odds.

The concept, as examined here, is not necessarily designed to result in one of the two principal rail rights-of-way becoming a "passenger-only" line, with all of the freight being shifted to the other line. The creation of a passenger-only track — especially using the present CN's Lakeshore route — could result in significant freight access problems and harm to local industry. Rather, the focus is on a system where one route would be optimized for, and carry, the passenger traffic and the other optimized for, and carry, most of the freight.

2.2 REQUIREMENTS FOR A UNIFIED SYSTEM OF TRACK

To achieve a workable collective or separated track operation, a blend of technical and operational changes would be necessary.

On the technical side, the CN and CP Toronto to Montreal tracks would need to be connected in four or more locations to allow reasonably convenient access from the northern, predominantly freight track (the present CP mainline) to freight yards and shippers to the south (on the present CN line). There would need to be fully automated, interlocked crossovers that allowed movement between the tracks at reasonable speeds. There are many points where such crossovers could be located. (See subsection 2.3.)

The second major technical change would be a requirement for an integrated signal, train control, and dispatching system for the two tracks, which could be tied into the individual CN and CP systems at each end. The integrated control system should not present insurmountable difficulties, especially since both railways have shown serious interest in the implementation of Advanced Train Control Systems (ATCS).

Other issues needing resolution would include redefining crew districts and seniority systems to reflect the different routing some of the freight trains may take, plus training freight train crews for the additional route. Both railways have successfully negotiated such issues in the past as a result of other structural changes in the railway system. It would also be necessary to develop some changes in the way liability for accidents is assessed. Again, CN, CP and VIA Rail have operated with running rights over parts of other railway systems and have developed methods of dealing with the issue.

Another issue that must be addressed is the capacity of the one route — in this discussion, the CP track — to efficiently handle the additional freight traffic displaced from the other route. In general, the capacity appears to exist, but there could be degradation of express-train trip times — which both CN and CP may find unacceptable for market reasons. Additional siding capacity would be needed on the single-track section between Toronto and Smiths Falls. Without simulation of the train configurations and dispatch times, it is difficult to predict the extent of the additional capacity requirements.

2.3 FREIGHT ACCESS

The development of satisfactory freight access from the present CP mainline to the present CN Lakeshore track seems possible at the cost of investing in new connections. Freight access is not as much of an issue on other segments of the "triangle." VIA Rail is the only user of, and has purchased, the Smiths Falls to Ottawa segment of

the track. Between Brockville and Smiths Falls there is presently very little freight traffic, and this is unlikely to interfere with the passenger trains. On this segment, most passenger delays are due to the transition between the two routes at Smiths Falls. Thus, greater specialization of track use, in itself, could not be expected to be of any significant benefit to the passenger system; a by-pass or new connecting tracks would be required to make any noticeable improvement. (This has not been included in the notional cost estimates that appear later.)

On the Ottawa to Montreal route (CN's Alexandria Subdivision), there is little opportunity to provide alternative freight access for local traffic. The line also carries Ottawa to Montreal freight trains and some freight trains between western Canada and Montreal. There is alternative routing from the Lakeshore track to Ottawa via the CP Prescott Subdivision, and traffic from western Canada can be rerouted via CP's mainline through Smiths Falls.[6]

It should also be noted that VIA Rail presently owns most of CP's old M and O Subdivision right-of-way that runs from Ottawa to Dorion. The track has been removed from this route. While this would be a straight and direct route for passenger service, it would require new track at substantial cost.

2.4 BENEFITS OF REDUCED FREIGHT INTERFERENCE

It is sometimes suggested that reducing the number of freight trains on the Lakeshore track could create a significant benefit in improved passenger trip times since there would be less interference between freight and passenger trains. This is not likely to be the case. First, much of the CN freight traffic is scheduled at night and other times when there are no passenger trains, and some daytime freight trains do not operate on an express schedule, instead waiting for the passenger trains. Second, the Lakeshore route is a full double-track system with a significant siding capacity, which reduces freight and passenger interference.

In overall terms, our investigations suggest that there is little freight interference delay built into VIA Rail's present express-train times between Toronto and Montreal. If anything, there may be more inter-ference between individual passenger trains at station stops.[7] Other potential interference between the freight and passenger systems is more incidental and can be eliminated or reduced without restricting the number of freight trains.[8] On average, reducing freight-passenger interference by restricting the number of freight trains on the Lakeshore route could only shorten the passenger-trip time by a few minutes — because mainly through-freight (which interferes little) could be shifted to the CP route, and the present level of way-freight activity (which interferes more) would continue.

Of more benefit may be the potential for greater schedule flexibility (arrival and departure times) that might be gained through reducing the number of freight trains on the Lakeshore route. However, this type of freight and passenger interference often takes place in urban areas and at other points where geography limits the potential for reducing the number of freight trains. For example, eastbound CN freight access from the Montreal yard over the Victoria Bridge to the Maritimes appears to be one of the governing factors in the scheduling of passenger trains into and out of Montreal's Central Station. Given the importance of the timeliness of these trains to the Halifax container terminals, competing against Montreal and U.S. rivals, there is only limited flexibility here.

2.5 BENEFITS OF HIGHER SPEED LIMITS

Given the present demands on the transportation system, greater potential benefits from the creation of a "passenger-optimized" Toronto to Montreal route may result from raising the passenger train speed limit. At present, with a mix of freight and passenger trains — operating over level crossings at quite different speeds — the pas-senger train speed limit is 95 mph (153 km/h). Steps that might be taken to improve passenger train trip times include adjusting crossing

signal timings to safely allow higher speed operation through grade crossings, and resetting curve super-elevations more in line with passenger train speeds.

How much and what type of freight remains on the passenger-optimized line will be important. Assuming that higher speed operation through grade crossings is considered reasonable — Amtrak allows 110 mph (177 km/h) operation through grade crossings in the Northeast Corridor — it would be necessary to reset all of the grade-crossing protection circuits to provide the necessary warning time at higher speeds. Presuming some freight traffic is to be retained, it would be advantageous to provide some form of "smart" grade-crossing circuits that would detect the difference in train speeds and provide the appropriate warning time. (Imposing a long wait on motorists for a slow freight train undermines crossing signal credibility, and encourages motorists to take risks.) The technology for smart grade crossings is available, but its installation could be expensive.

Resetting curves would allow passenger trains to negotiate them at a higher speed, but curves cannot be fully optimized for passenger service if freight traffic is to be continued. While there are curves on the Lakeshore route, it is not overly curvaceous. Thus, the potential gains in trip time will be limited. On the other hand, if one were prepared to wait, the cost of resetting curves would be modest, since much of this work could be carried out as part of the routine and scheduled track maintenance programs.

In terms of the signal system itself — for protecting following and opposing train movements — preliminary investigations do not suggest that much additional investment would be required to allow higher passenger train speeds within the range that is being considered. It appears that present block lengths and stopping distance allowances would be sufficient to allow 105 mph (170 km/h) or higher operation in many of the non-urban areas of the Lakeshore route.

How much time could be gained on a Toronto to Montreal trip? VIA Rail's present best trip time with an F-40 locomotive and four LRC cars is 4 h 10 min with an intermediate stop only at Dorval. For every 5 mph (8 km/h) gain in the average achievable speed in the non-urban areas (roughly Pickering to Dorval), approximately 10 minutes could be taken off the trip time. A 20-minute improvement in trip time might be achievable — perhaps a bit more — without substantial investment (more than estimated in subsection 2.6). In addition, there appear to be other modest investments that would result in a savings of trip time. What is not at all clear is how much of the overall time savings may be achievable within the present context, and how much might require the shifting of freight traffic.

An important issue in improving train speeds on the Lakeshore route that is often overlooked is the capabilities of the rolling stock itself. The LRC locomotive has been tested to speeds as fast as 125 mph (200 km/h), although neither CN nor VIA Rail would want to operate such a heavy locomotive at that speed. The newer F-40s have been cleared to operate at 95 mph (153 km/h). It is not known how much more speed can be gained from this equipment. What is clear is, however, that going to much higher speeds would require the shortening of the trains or adding a second locomotive. Under present circumstances, the addition of even one car to a four-car LRC-powered train would result in a noticeable performance degradation if run to VIA Rail's fastest schedule. The potential need for more powerful locomotives, or for a second locomotive unit, will have to be included in any analysis of the gains from increased speed. In many cases, the second locomotive may already be available in the present (or projected) fleet to handle peak train sizes; it simply is not used on days when demand dictates a shorter train.

2.6 NOTIONAL CAPITAL COSTS FOR AN INTEGRATED SYSTEM

In terms of infrastructure investment, costs of a general order of $60 million would be required to interconnect the two systems

substantially to allow ease in rerouting intercity freight trains and faster passenger-train operation. The following are the types of investment required:

Table 6(2)-1
COST OF INVESTMENTS FOR AN INTEGRATED SYSTEM

Investment	Notional cost
Provision of interconnections between CN and CP main track	$15 million to $20 million
Provision of new signal interlockings and consequent changes	$15 million to $25 million
Alteration of grade-crossing circuits (Lakeshore)	$10 million to $20 million
Improvements to CP main track	about $5 million
Total	**$45 million to $70 million**

2.7 NOTIONAL TRACK OPERATING AND MAINTENANCE COSTS

An examination of VIA Rail's cost data indicates that approximately $15 million is paid annually to CN and CP (mostly CN) for use of the track between Toronto, Ottawa and Montreal as defined in the subject network. This figure is higher than that paid under the basis of esti-mated system-average variable unit cost, which was used in the past for determining compensation to the freight railways for passenger train use. It reflects an acceptance of the propositions that:

• the passenger service constitutes a substantial component of the traffic between Toronto and Montreal, and accounts for costs that would not be avoidable under most Canadian passenger-rail circumstances;

• for track for which VIA Rail is sole user, it must pay the total (not just the variable) cost;

• the costs of maintaining a track for higher than average speed passenger operations are higher than average; and

• incentive payments for service can be effective where regulatory compulsion fails.

CN's and CP's total cost,[9] not including corporate overhead, of maintaining and operating track in this network is about $75 million per year. (This amount includes the cost of train dispatching; the area includes the links to Ottawa.)

2.8 ATTRIBUTION OF COST

Shifting the proportions of freight and passenger to concentrate freight on the CP line would result in a larger proportion of the present CN track costs being attributed to the passenger system, especially that portion of the costs independent of traffic levels. Routine rail replacement and other maintenance requirements for the track specialized for passenger use can be expected to decrease simply because of the decreased traffic levels.[10] At the same time, higher passenger speeds would cause increased unit costs from:

• increased track damage due to dynamic loads; and

• tighter track (line, level and gauge) tolerances.

Presumably the track would be priced on the basis of the value of the service provided; traffic that could not cover its marginal cost would not be accepted. Estimates of service value and marginal cost are far beyond the scope of this very preliminary exploration; however, two cost allocation possibilities — essentially limits within which true causality should fall — are shown in Table 6(2)-2.

Table 6(2)-2
ALLOCATION OF NOTIONAL TRACK OPERATING COSTS

Allocation	Proportion of traffic		Allocated cost	
	Tonne-km (%)	Train-km (%)	Tonne-km ($ million)	Train-km ($million)
Passenger	11	40	8	30
Freight	87	57	65	43
Commuter	2	3	2	2

Table 6(2)-2 does not include any charges for administration of a track operating authority or for necessary capital investment. Nor are GO Transit's track ownership or maintenance costs considered. It will be seen that annual operating costs allocated to passenger rail could well exceed current VIA Rail payments for track use by $5 million to $10 million. In addition, some portion of the roughly $60 million in one-time capital costs should be attributed to the passenger rail service. Track specialization, and the modest investment in track upgrading for passenger-only use, might improve the time of the faster Toronto to Montreal train from 4 h 10 min to about 3 h 30 min.

ENDNOTES

1. This proposal considered joint CN and CP operations in the Fraser Canyon with west-bound trains using CN tracks and eastbound trains using CP tracks. De Leuw Cather Canada Ltd., *Joint Track Usage Study: Kamloops–Mission B.C.*, November 1985.

2. An early reference to *running rights* appears in the *Railways Clauses Consolidation Act,* (8 Vict. c.20) of 1845 (British). Much Canadian railway legislation was patterned on this statute.

3. The running rights provisions in the *Railway Act* and the NTA, 1987 only apply to federally incorporated railways (this includes U.S. railroads connecting into Canada). The National Transportation Agency can order a federal railway to permit a connection with a provincially incorporated railway.

4. Recommendation by the National Transportation Agency and sanction by the Governor in Council are also required.

5. MOQ Rail is developing a prototype operation using highway type trailers fitted with both highway type wheels and steel rail type wheels. The motive power would be provided by highway style cabs. The trailer concept has similarities to the successful RoadRailer system operated by Triple Crown (a subsidiary of Norfolk Southern) in the United States. The motive power is a new departure.

6. Such a scheme for trains to and from western Canada has been discussed for many years and may have benefits for CN and CP independently of any passenger system benefit.

7. For example, four passenger trains stop at Kingston during a half-hour period on weekday mornings. Often, one or more of these trains must wait for one of the other passenger trains to clear the station.

8. For example, at Brockville, additional delay is sometimes incurred because there is direct foot access to only one track, and there is no physical barrier between the two main tracks. Providing a passenger underpass or overpass, and building a fence between the tracks would eliminate some of the problems here.

9. Operating cost and sustaining capital.

10. The counterpart to much of this savings would be increased replacement and maintenance requirements for the CP track to which the freight traffic would be shifted.

ANNEX 1

THE *NATIONAL TRANSPORTATION ACT, 1987*

Provisions of the *National Transportation Act, 1987* (NTA, 1987) dealing with running rights and joint track usage are under the title Railway Freight.

- Section 148 authorizes the National Transportation Agency to direct one railway company to provide access to another and to set the required amount of compensation the user must pay. The Agency may exercise this power where the two companies cannot reach an agreement and rail access is deemed to be in the public interest.

- Section 149 authorizes the Governor in Council, after specified process, to order common use of a railway right-of-way and fix the amount of compensation to be paid for that common use.

Presumably such provisions apply solely to freight. There is no obvious reason why they should not also be made applicable to passenger rail.

Subsection 174(6) provides that when a railway line is transferred from one railway company to another, the selling railway is relieved of its obligations related to the operation of that line under the NTA, 1987 or any other Act of Parliament. However, when VIA Rail has an existing operation on a line sold by a federal company to another company (either federal or provincial), the line remains under federal jurisdiction. The acquiring company inherits all the obligations of the selling company, including those under the *Canada Labour Code*, for example, the selling railway's collective agreements.

If a line with VIA Rail service transferred from one company to another is then abandoned, or VIA Rail service is discontinued, the line is no longer deemed to be a work for the general advantage of Canada and may be transferred out of federal jurisdiction.

NOTES TO CHAPTER 7:
ENVIRONMENTAL EFFECTS OF INTERCITY PASSENGER TRANSPORTATION

1. Introduction

The Royal Commission's considerations of environmental issues were aided by two pieces of contracted research. The first is by VHB Research & Consulting Inc., "Environmental Damage from Transportation," published in Volume 4 of this report,[1] which summarizes the nature and effects of environmental damage, and provides estimates of air pollutant emissions by intercity passenger mode in Canada. It also considers the practicality of methods of assessing the social costs of environmental damage, and offers some estimates of the costs of air pollution per mode. In view of its availability in Volume 4, only the briefest summary of the effects will be provided in these notes.

The second piece is by William A. Sims, "Externality Pricing," which is distributed as RR-07 in the series of reports prepared for the Royal Commission.[2] It reviews the theoretical case for direct pricing of such externalities as environmental damage, from the economic literature. The policy issues in charging for environmental damage, or otherwise approaching damage mitigation through economic incentives/ disincentives, are also reviewed thoroughly in a Government of Canada paper that became available during the Commission's deliberations, *Economic Instruments for Environmental Protection.*[3]

1.1 MAIN ENVIRONMENTAL EFFECTS

The environmental effects of passenger transportation that are of main policy concern are:

- air pollution;
- global warming; and
- noise.

Another important environmental effect is the disruption of local communities by transport infrastructure and traffic.

These effects all cause harm to natural ecosystems or to people or communities, but harm that is outside our normal system of markets. Thus, it is unpriced, failing to appear as a cost to the transport carrier or passenger. These effects also all differ spatially, seasonally and by time of day. A pricing system that incorporated these "externalities" in decisions about infrastructure investment and use would (at least to some extent) reduce the extent of transportation, and cause shifts toward those modes of travel, locations and times that would cause less environmental damage.

Most of what follows in these notes refers to air pollution and global warming because those are the effects for which most information is available. It is anticipated that a policy framework dealing with these effects should also apply to noise and community disruption; some relevant policy aspects of the damage are mentioned below.

2. EMISSIONS FROM ENGINES AND VEHICLES

2.1 EMISSIONS OF MAIN CONCERN[4]

2.1.1 Volatile Organic Compounds

Volatile organic compounds (VOCs) include the volatile hydrocarbons of unburned fuel in exhaust gases, or evaporated from engines and gas tanks (and filling stations). These are of concern primarily because of their contribution to the formation of low-level ozone (discussed later). About 40% of all VOCs from non-natural (man-made) sources originates from transportation.

2.1.2 Nitrogen Oxides

Oxides of nitrogen (NO_x) are fuel combustion by-products, formed particularly at high engine temperatures, and, therefore, disproportionately by diesel engines. Nitrogen dioxide (NO_2) is of concern because it can cause harm to health and damage to vegetation, and it reduces urban visibility (forming the brown haze on hot days in large cities). Through chemical conversion, NO_x also contributes to

the formation of ozone and of nitric acid, a component of acid rain. Transportation is responsible for about 60% of all non-natural NO_x emissions.

The most important, and complex, role of transportation NO_x is in the formation of ozone. This gas is important to the environment in two very different ways. More familiar to the public is the "ozone layer" in the high atmosphere, which acts as a reflective screen against solar ultraviolet radiation, preventing harmful amounts of radiation from reaching the Earth's surface, where they would add to global warming and increase skin cancer. The concern is that this layer is being depleted through artificial disruption of natural processes.

Quite the opposite concern is expressed when ozone exists in the atmosphere close to ground level, where its effects are harmful rather than beneficial. Low-level ozone is formed from chemical conversion of NO_x in sunlight, with VOCs aiding the reactions. Non-natural emissions are partially responsible, including those from transportation. This "low-level" ozone can be transported downwind, but breaks down through further chemical processes within hours or days. Concentrations increase over cities with high NO_x and VOCs emissions, particularly in summer, in "episodes" that last a few days. Effects can be felt over regions encompassing groups of cities arranged along the direction of the prevailing air currents, and over the intervening rural areas.

Ozone concentrations are greatest in three regions of Canada: the Lower Fraser Valley of British Columbia; the "corridor" between Windsor, Ontario, and Quebec City, Quebec; and in the area of Saint John, New Brunswick. Ozone originating from adjacent U.S. industrial areas is largely responsible for the concentrations in the latter region, and contributes substantially to concentrations in southern Ontario and Quebec.

Potential harmful effects of low-level ozone include respiratory problems and damage to foliage of crops and trees. Furthermore, ozone

in the lower atmosphere itself acts as a "greenhouse gas," absorbing heat radiated from the Earth and adding to global warming.

The low-level ozone is effectively unconnected to the high-level "ozone layer," so the Earth faces simultaneously an excess of ozone in the lower atmosphere and depletion in the upper atmosphere.

The contribution of transportation NO_x to ozone formation, as well as its effects, depends on the altitude at which the emissions occur. As the great bulk are at ground level (from motor vehicles, trains and ships), the main potential problem is the direct damage ozone causes to people and foliage.

Aircraft emissions, however, present different problems. There is increasing evidence that NO_x emitted by aircraft in the high tropo-sphere (at the cruising altitude of modern jets) is particularly potent at producing ozone.[5] That ozone is unlikely to reach people and crops at ground level, but might be adding substantially to global warming. Furthermore, supersonic aircraft operate at much higher altitudes, close to, or even within, the "ozone layer." Paradoxically, their emis-sions of NO_x at those altitudes do not create ozone, but actually con-tribute to its depletion. At present, there are very few such aircraft operations, but if the supersonic fleet were to expand greatly, control of their NO_x emissions might become a priority.

2.1.3 Carbon Monoxide

Carbon monoxide (CO) is a combustion by-product with potentially serious health effects. About 60% of total non-natural emissions are from transportation, and 75% of transportation emissions come from passenger cars, pick-up trucks and vans.

2.1.4 Particulates

Particulates are solid materials in engine exhaust, consisting of about 75% carbon (soot) and 25% "polycyclic aromatic hydrocarbons," which potentially cause cancer. Transportation sources account for

only about 1.3% of total non-natural particulate emissions, but a larger portion of the very small particles that are considered more problematic (those less than one hundredth of a millimetre in diameter). Very small particles are emitted more by diesel engines than by gasoline engines or turbines.

2.1.5 Sulphur Dioxide

Sulphur dioxide (SO_2) is a by-product of burning fossil fuels containing sulphur. It is of concern for its potential direct health effects and also its conversion to form sulphuric acid, the predominant acid in acid rain. Emissions depend on the amount of sulphur in fuels (including how much is removed from oil during refining). The sulphur content of diesel is higher than that of gasoline and aviation fuel, and is greater for marine diesel than for diesel used in motor vehicles or trains. Transportation contributes only about 2.2% of total non-natural emissions in Canada, of which one third is from marine engines. Non-ferrous smelting and thermal power generation provide the bulk of emissions.

2.1.6 Chlorofluorocarbons

Chlorofluorocarbons (CFCs) are used as blowing agents, coolants in air conditioning systems and refrigeration in all transport modes, and in foam padding and seats. CFCs are of concern for their destruction of the ozone layer. Motor-vehicle air conditioners have recently contributed about 25% of Canadian CFC emissions; the remainder comes largely from commercial refrigeration and air conditioning. Replacement chemicals are expected to be introduced rapidly in accordance with Canada's announced goal to eliminate CFC use by 1997. (This goal is discussed later in this chapter.)

2.1.7 Carbon Dioxide

Carbon dioxide (CO_2) is a by-product of combustion of any carbon-based fuel (such as oil, coal or wood), and is of concern as the major contributor to the "greenhouse effect" of global warming. Unlike VOCs, NO_x and CO, which can be controlled by exhaust-treatment

techniques, CO_2 remains unchanged, and therefore varies directly with the amount of fuel used. About one quarter of total non-natural emissions are from transportation, the bulk of the remainder being from power generation, industrial energy use and space heating. CO_2 is released naturally by all plants and animals as a consequence of energy production (as when the body processes food carbohydrates and oxygen into energy, creating waste products of carbon dioxide and water vapour); CO_2 is also the result of natural decaying or burning of vegetation, and of volcanic activity.

2.2 AMOUNTS OF EMISSIONS BY INTERCITY MODES

Emissions by mode, in grams per unit of fuel used, were obtained from the VHB study for the Royal Commission, reproduced in Volume 4 of this report.[6] Estimates are provided of energy use by mode in megajoules per passenger-kilometre, and of emissions in grams per passenger-kilometre of CO_2, SO_2, NO_x, non-methane hydrocarbons (VOCs), particulates and CO. For intercity passenger travel, and the attempts to cost and price the environmental damage, it is assumed that the crucial emissions are those of CO_2, NO_x and VOCs, so the estimates that follow are confined to those.

The estimates of emissions for passenger cars were modified to combine estimates for cars and light trucks, based on light truck emissions of NO_x and VOCs being 20% greater per vehicle-kilometre than car emissions. (This value was derived from weighted national averages of the information in Tables 5 and 6 of the VHB report.) Highway fuel consumption, and therefore CO_2 emissions, are estimated to be 33% higher per vehicle-kilometre for light trucks (12 L/100 km versus 9 L/100 km). The combined results appear as estimates for "cars" in the tables.

The estimates of average fuel consumption by mode were also modified by the Royal Commission staff, as discussed in the Notes to Chapter 3. The VHB estimates of emissions by mode have been converted first to grams per megajoule (g/MJ) of fuel, represented in Table 7(2)-1.

Table 7(2)-1
RATIOS OF EMISSIONS TO ENERGY USE (g/MJ)

Mode	CO_2	NO_x	VOCs
Bus	70.8	0.915 to 0.962	0.106 to 0.135
Car	73.8	0.388 to 0.482	0.488 to 0.599
Train	70.7	1.428 to 1.442	0.069 to 0.195
Airplane	70.8	0.045 to 0.174	0.030 to 0.037
Ferry	81.6	0.091 to 0.120	0.009 to 0.012

These are multiplied by estimated system-wide average consumption of MJ of energy, obtained from Royal Commission staff estimates of average fuel use, as in Table 7(2)-2.

Table 7(2)-2
SYSTEM-WIDE AVERAGE FUEL USE BY MODE

Mode	Energy/Fuel (MJ/L)	Amount travelled/ Fuel (pass-km/L)	Energy/Amount travelled (MJ/pass-km)
Bus	38.68	57.8	0.67
Car	34.66	18.6	1.86
Train	38.68	23.4	1.65
Plane	37.68	9.7	3.88
Ferry[a]	38.68	5.2	7.39

a.   See endnote 7.

Then multiplying g/MJ by MJ/pass-km gives grams of emissions per passenger-kilometre by mode, as in Table 7(2)-3.

Table 7(2)-3
ESTIMATED EMISSIONS PER PASSENGER-KILOMETRE (g/PASS-KM)

Mode	CO_2	NO_x	VOCs
Bus	51.7	0.500 to 0.860	0.070 to 0.100
Car	125.5	0.659 to 0.819	0.829 to 1.019
Train	116.9	2.361 to 2.385	0.115 to 0.323
Plane	274.9	0.175 to 0.676	0.116 to 1.144
Ferry	603.0	0.672 to 0.887	0.067 to 0.089

2.3 SUMMARY OF KNOWLEDGE OF EFFECTS[8]

2.3.1 Health

The federal government has established National Ambient Air Quality Objectives (NAAQOs)[9] for the major pollutants, specifying levels that are the maximum "acceptable," intended to provide adequate well-being and personal comfort. Measurements of pollutants are taken continually by Environment Canada at numerous sites across the country. Interpretation of the results shows that, while there are some potential health problems posed by high local concentrations of CO, NO_2 and diesel particulates, none of these is found routinely in concentrations that violate the National Ambient Air Quality Objectives.[10]

A much greater concern is the exposure of people to low-level ozone. Canada's NAAQOs for a one-hour exposure to ozone is exceeded occasionally in most large cities, and regularly so in the Lower Fraser Valley of British Columbia, southern Ontario, the area of Quebec between Montreal and Quebec City, and southeastern New Brunswick.[11] There is evidence that ozone at these concentrations causes breathing difficulties, particularly among asthmatics (5% of the population). Periods of high ozone have also been linked with increases in hospital admissions and use of medication for respiratory problems.[12]

2.3.2 Materials

Acid rain can affect building stone and mortar; NO_2, nitric acid and ozone can affect paints; NO_2 and ozone can affect fabrics; SO_2, NO_2 and nitric acid can affect metals. But the laboratory demonstrations of these effects are conducted using concentrations far higher than exist in Canada. The VHB research report for the Royal Commission concludes there is "no evidence that existing levels in the Canadian environment adversely affect materials."[13]

2.3.3 Forest Resources

Substantial effects of acid rain on germination and survival of tree seedlings are seen only at levels of acidity higher than found in Canadian rainfall, and no definitive trends in responses of forests to ozone have been found.

2.3.4 Crops

Effects of ozone in damaging foliage, and therefore crop yields, are well established, with resulting reductions in annual crop values estimated for Ontario at $15 million to $23 million in 1984.[14] NO_2 and acid precipitation at Canadian levels are not thought to cause substantial damage to crops.

2.3.5 Fish

NO_x deposited as acid rain has adverse effects on life in eastern Canadian lakes. Approximately 150,000 lakes are being damaged, more than 14,000 of which have been described by Environment Canada as "acidified."[15]

2.4 GLOBAL WARMING

Scientific concern has increased that non-natural additions of certain gases to the atmosphere increase the atmosphere's retention of radiated heat in a "greenhouse effect" that raises average global surface temperatures. Research has not produced definitive findings on the extent and effects of such warming, so an Intergovernmental Panel on Climate Change was established in 1988, under the United Nations Environment Programme. This panel of scientists reviewed the scientific evidence, concluding:

We are certain of the following:

- There is a natural greenhouse effect which already keeps the Earth warmer than it would otherwise be.

- Emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse

gases: carbon dioxide, methane, chlorofluorocarbons and nitrous oxide. These increases will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface.[16]

The panel predicts that, if no control measures are taken, global mean temperature will rise above pre-industrial levels by more than 2°C by 2050 and 4°C before 2100. Among the important effects, thermal expansion of the oceans and melting ice would raise global mean sea level by about 6 cm per decade.

The Canadian Climate Program Board has predicted that the potential effects in Canada would include:

- a shift of climatic zones several hundred kilometres northward over the next 50 years, significant degradation of permafrost, changes to ecosystems and wildlife habitat at so fast a rate that some species may be unable to survive, disruption to northern indigenous people, and threats to northern buildings and pipelines;

- increased drought risks, especially in the Prairies;

- increased probabilities of forest fire and insect and disease attacks;

- adverse effects on human health from more frequent and intense heat waves in cities, and the northward spread of tropical diseases; and

- an increase in soil erosion, changes to coastal ecology, damage to wetlands and important fisheries, and substantial costs for coastal protection due to rising sea levels.

The Board also suggests there is some potential for northward expansion of agricultural crops where soils permit.[17]

Descriptions of potential global effects are provided in a recent U.S. National Academy of Sciences study.[18] To date, estimates of the costs that would be imposed by the predicted effects have not been

made for Canada, and are rare worldwide. Predictions of the effects by sector of activity in the United States lead Nordhaus[19] to suggest that identifiable costs would be equivalent to about one quarter of 1% of national income, and his judgement is that including unmeasured effects and uncertainty puts the upper limit at 2% of national income.

3. CURRENT AND ANNOUNCED CONTROL STRATEGY FOR AIR POLLUTION

3.1 VEHICLE EMISSION STANDARDS

Control of transportation air pollutants is mostly by federal regulation of limits for emissions from new vehicles, and is essentially limited to road vehicles. Aircraft jet engines are subject to limits set by the International Civil Aviation Organization, to which all Canadian engines conform, even though the standards have no legal force in Canada. No regulations exist for locomotive engines. Ships are subject only to a federal smoke limit, which is a remnant of the coal-fired steamship era.

Motor-vehicle exhaust emissions are controlled by regulations for new vehicle performance under the federal *Motor Vehicle Safety Act*, administered by Transport Canada. The standards were tightened substantially for new cars in 1986 and new trucks in 1988, essentially to be equal to U.S. standards. Those standards in the United States have since been made even more stringent, and plans have been announced by Environment Canada and Transport Canada to "harmonize" with those shortly.[20] Thereafter it is the intention to maintain equivalence with the United States, thus continuing to have the most stringent standards in the world. Those plans also include examining the feasibility of regulating emissions released by aircraft, ships and trains.

Emissions through the lifetimes of motor vehicles are regulated to some extent through the new vehicle standards, which specify performance to be met over a designated vehicle lifetime. Nevertheless,

emissions can increase over lifetime through poor maintenance or tampering with emission control equipment. Provincial programs of compulsory periodic emissions testing are proposed in the NO_x/VOCs Management Plan for the "ozone non-attainment areas" of southern British Columbia and the Windsor to Quebec City corridor (see description of the Plan, which follows). British Columbia introduced a testing program for cars and light trucks in the lower mainland in September 1992.

3.2 ANNOUNCED NATIONAL OZONE CONTROL STRATEGY

3.2.1 Multinational Goals

NO_x: Under the NO_x Protocol of 1988, Canada and 24 other countries are committed to freezing national NO_x emissions at 1987 levels. Canada's strategy is contained in the NO_x/VOCs Management Plan.

VOCs: By a similar international agreement signed in November 1991, Canada will by 1999 freeze VOCs at 1988 levels, and reduce them by 30% in two areas designated under the agreement as "tropospheric ozone management areas": the Lower Fraser Valley and the Windsor to Quebec City corridor.

3.2.2 NO_x/VOCs Management Plan

Recognizing ozone as the prime air pollution problem in Canada, the Canadian Council of Ministers of the Environment (CCME) adopted, in November 1990, a Management Plan for NO_x/VOCs.[21] The Plan includes a number of new nation-wide regulations, which in the transport sector involve further tightening of motor-vehicle emission standards starting in 1996. In addition, the Plan designates the three Canadian regions that frequently exceed ozone NAAQOs as "ozone non-attainment areas": the Lower Fraser Valley, the Windsor to Quebec City corridor, and the Saint John area. For these, separate targets for NO_x and VOCs reductions are being negotiated with the provinces concerned, and the plan envisages adopting special local control

measures. The list being considered initially includes, for the transport sector:

- more rigorous speed-limit enforcement in summer;

- motor-vehicle inspections and anti-tampering laws;

- reduction in summer gasoline volatility; and

- evaporative loss controls at refuelling stations.

The plan includes forecasts to 2005 of expected changes in emissions, based on economic and population growth estimates, National Energy Board (NEB) estimates of energy demand by sector of activity, and demand growth estimates and input fuel mixes for electricity generation provided by provincial power utilities. For road transportation, it includes forecasts of vehicle sales provided by the Motor Vehicle Manufacturers Association, together with NEB estimates of total vehicle fleet size and use (assuming constant annual kilometres per vehicle).[22]

Effects of the Plan were predicted as changes in these forecasts. Some details of the main sources of NO_x and VOCs are shown in Tables 7(2)-4 and 7(2)-5, together with predictions for 2005 with and without the impacts of the new Plan. It can be seen that emissions of both NO_x and VOCs were predicted to increase by about 6% from 1985 to 2005 in the absence of the Plan, as growth in the use of stationary sources outweighed the very substantial continuing reductions in transport sources resulting from already-established motor-vehicle standards. The Plan expects NO_x levels to decrease until 1995 due to a sharp decline in emissions from light and heavy vehicles. This will result from increasing numbers of vehicles equipped with emission controls that meet recent standards, combined with modest reductions in rail emissions. These transportation reductions outweigh increases in emissions from other sectors until about 1995. Thereafter, the increases in motor-vehicle use are expected to offset remaining reductions in average fleet emissions per vehicle-kilometre, so that total national emissions first flatten and then begin to rise slowly as emissions continue to grow in other sectors.

Table 7(2)-4
NITROGEN OXIDES EMISSIONS AND PROJECTIONS TO 2005

Source	1985 (kt)	Propor-tion of total (%)	2005 base case (kt)	Change from 1985 (%)	2005 with plan[a] (kt)	Change from 1985 (%)
Transport						
Road						
Cars, light trucks	453	24.0	238	−47	169	−63
Heavy trucks	285	15.1	260	−9	235	−18
Off-road	261	13.8	346	+33	338	+30
Subtotal road	999	52.9	845	−15	742	−26
Air	33	1.8	42	+27	42	+27
Water	15	0.8	19	+24	19	+24
Rail	132	7.0	113	−15	113	−15
All transport	**1,180**	**62.5**	**1,018**	**−14**	**916**	**−22**
Stationary sources						
Power generation	248	13.1	352	+42	230	−7
Natural gas industry	159	8.4	205	+29	202	+27
Indust./comm. fuel use	145	7.7	207	+43	141	−3
Residential fuel use	41	2.2	37	−11	33	−20
Industrial processes	89	4.7	140	+57	129	+45
Other	25	1.3	36	+44	37	+48
All stationary sources	**707**	**37.5**	**977**	**+38**	**772**	**+9**
TOTAL	**1,887**	**100.0**	**1,995**	**+6**	**1,687**	**−11**

Source: Canadian Council of Ministers of the Environment, *Management Plan for Nitrogen Oxides and Volatile Organic Compounds, Phase I*, November 1990.

a. After implementation of the measures currently outlined in the NO$_x$/VOCs Management Plan.

Table 7(2)-5

VOLATILE ORGANIC COMPOUNDS EMISSIONS, AND PROJECTIONS TO 2005

Source	1985 (kt)	Propor- tion of total (%)	2005 base case (kt)	Change from 1985 (%)	2005 with plan[a] (kt)	Change from 1985 (%)
Transport						
Road						
Cars, light trucks	557	31.2	350	−37	262	−53
Heavy trucks	54	3.0	48	−11	48	−11
Off-road	90	5.0	109	+22	109	+22
Subtotal road	700	39.3	507	−28	419	−40
Air	10	0.6	13	+30	13	+30
Water	28	1.6	32	+13	32	+13
Rail	7	0.4	6	−15	6	−15
All transport	**745**	**41.8**	**558**	**−25**	**469**	**−37**
Stationary sources						
Solvent use	502	28.2	603	+20	431	−14
Industrial processes	152	8.5	239	+57	173	+14
Fuelwood combustion	108	6.0	133	+23	133	+23
Slash burning	80	4.5	129	+60	129	+60
Gas distribution	109	6.1	124	+14	67	−39
Industrial fuel use	50	2.8	64	+29	60	+21
Other	36	2.0	42	+17	42	+17
All stationary sources	**1,037**	**58.2**	**1,334**	**+29**	**1,034**	**(no change)**
TOTAL	**1,782**	**100**	**1,892**	**+6**	**1,504**	**−16**

Source: Canadian Council of Ministers of the Environment, *Management Plan for Nitrogen Oxides and Volatile Organic Compounds, Phase I*, November 1990.

a. After implementation of the measures currently outlined in the NO_x/VOCs Management Plan.

For VOCs, a rapid decline in emissions is also expected from motor vehicles in the short term, outweighing increases in other sectors. Motor vehicles, however, contribute a smaller proportion of total VOCs emissions than total NO_x emissions, and their reductions are expected to be overtaken earlier than 1995 by persistent increases in VOCs from non-transportation sources.

Adopting proposals identified in the national Plan would reduce total NO_x emissions in 2005 by about 11%, and VOCs emissions by 16% over recent levels. The Plan also envisages tightened objectives and extended programs in the future, particularly in the non-attainment areas.

The CCME forecasts that implementing the Plan will substantially reduce peak ozone concentrations and periods exceeding the maximum acceptable NAAQO. In 2005, the annual hours in excess of the latter standard would be halved in the Lower Fraser Valley and Saint John area, and reduced by 20% to 40% in the Windsor to Quebec City corridor, east of Toronto.[23] The improvements are expected to be even greater when combined with announced control programs in the United States. The CCME expects implementation of the amendments to the U.S. *Clean Air Act* to reduce NO_x emissions by 30% and VOCs emissions by 40% to 50% in those regions of importance to Canadian ozone concentrations (the U.S. Eastern Seaboard, the area south and west of lakes Erie and Ontario, and the Seattle area). This reduction will bring important additional reductions in periods exceeding the maximum acceptable NAAQO for ozone in southwest Nova Scotia and throughout the Windsor to Quebec City corridor, particularly to the west of Toronto.[24]

4. GLOBAL WARMING AND CANADA'S PROPOSED ACTIONS[25]

4.1 GREENHOUSE GAS EMISSIONS IN CANADA

Minor transport contributions to global warming arise from CFCs in automobile air conditioners and methane from natural gas distribution. Low-level ozone, to which transport emissions of NO_x and VOCs contribute, also adds to the greenhouse effect. All such contributions are dwarfed by transport emissions of CO_2 from burning carbon fuels.

4.1.1 Carbon Dioxide

Emissions of CO_2 in 1990, and projections for the years 2000 and 2010, are shown in Table 7(2)-6. It will be seen that transport accounts for

about 25% of the Canadian total of some 520 Mt, with road vehicles alone responsible for about four fifths of the transport contribution, or 20% of the total.

Table 7(2)-6
CARBON DIOXIDE EMISSION PROJECTIONS 1990–2010[a]

Source	1990 (Mt)	Proportion of total (%)	2000 (Mt)	Change from 1990 (%)	2010 (Mt)	Change from 1990 (%)
Transport						
Road						
Cars, light trucks	67	12.9	70	+4		
Heavy trucks	41	7.9	46	+12		
Subtotal road	108	20.8	116	+7		
Air	14	2.9	16	+18		
Water	5	1.0	6	+10		
Rail	3	0.6	4	+15		
All transport	**132**	**25.5**	**141**	**+7**	**150[b]**	**+15**
Stationary sources						
Residential	57	11.0	57	(no change)	57	(no change)
Commercial	27	5.2	30	+11	32	+20
Industrial	133	25.7	159	+20	200	+50
Producer consumption	77	14.9	93	+20	107	+40
Power generation	92	17.8	108	+17	130	+40
Total	**518**	**100**	**590**	**+14**	**675**	**+30**

Source: National Energy Board, and Transport Canada; distributions within transport sector interpolated from Transport Canada estimates for 1987 and 2005.

a.   One tonne of carbon dioxide contains 0.2727 tonnes of carbon.
b.   Modal breakdown not available for 2010.

The projections are made by the National Energy Board (NEB),[26] using historical relationships among CO_2, national output, population growth and energy prices. Central assumptions are that gross domestic product (GDP) will grow at 2.3% per annum, the number of house-holds at about 1.4% per annum, and the car stock at about 1.5% per annum, while the price of crude oil increases from US$20/barrel in 1990 to US$27/barrel in 2010 (in constant 1990 dollars). Growth in energy use overall and in CO_2 are expected to be at lower rates over

the next 20 years than during the last two decades, which will continue the substantial downward trend in emissions per unit of GDP.

The table shows that NEB's base-case forecast for 2000 is for total CO_2 to increase by 14% from 1990, to about 590 Mt. The overall growth predicted for transport sources to 2000 is about the same as for all other sources, but within transport the contributions of heavy trucks and aircraft increase faster than those of the other vehicle types.

By 2010, the base-case forecast is for emissions to increase by about 30% over 1990 levels to 675 Mt. The greatest increases are in industrial uses (50% over 1990 levels) and power generation and producer consumption (40%). Growth is expected to be only about 15% in the transport sector, and negligible in residential energy use.

4.2 CANADA'S GOALS ON GLOBAL WARMING

4.2.1 CFCs

With the protocol signed in 1987 in Montreal, Canada committed to a 50% reduction of CFCs by 2000. At the London Conference of June 1990, all original signatories agreed to increase the target to 100% phase-out by 2000, while Canada and 12 other countries declared they would eliminate CFCs by 1997. The prime motivation for CFC control is protection of the stratospheric ozone layer, but CFCs are also the most potent of the greenhouse gases per unit of weight.

4.2.2 CO_2

At the May 1990, UN Conference in Bergen, Norway, Canada committed to stabilize greenhouse gas emissions, other than CFCs, at 1990 levels by 2000. The CCME describes this as "a national target which does not pertain to specific regions or sectors." Canada is also committed to the UN Framework Convention on Climate Change, completed in May 1992, and signed by the Prime Minister at the UN Conference on Environment and Development in Rio de Janeiro in

June 1992.[27] That convention is less specific in its goals. Its objective reads in part (Article 2):

> The ultimate objective . . . is to achieve . . . stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

Its "commitments" in Article 4 include:

> Each of [the developed country] Parties shall adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs. These policies and measures will demonstrate that developed countries are taking the lead in modifying longer-term trends in anthropogenic emissions consistent with the objective of the Convention, recognizing that the return by the end of the present decade to earlier levels of anthropogenic emissions and other greenhouse gases . . . would contribute to such modification. . . .

and:

> In order to promote progress to this end, each of these Parties shall communicate, within six months of entry into force of the Convention for it and periodically thereafter, . . . detailed information on its policies and measures . . . as well as on its resulting projected anthropogenic emissions . . . with the aim or returning individually or jointly to their 1990 levels these anthropogenic emissions of carbon dioxide and other greenhouse gases. . . .

As illustrated by Table 7(2)-6, the goal of stabilization by 2000 at 1990 levels would require reductions in national CO_2 emissions by 14% from the NEB base-case forecast — in addition to the improvements in motor-vehicle fuel consumption and residential conservation already included in that forecast.

4.3 CO_2 REDUCTION MEASURES: TRANSPORTATION FUEL CONSERVATION

Federal fuel consumption policy has been limited to road vehicles, specifically cars, pick-up trucks and vans. In 1976, the government agreed with motor-vehicle manufacturers that the U.S. standards for fuel consumption of new vehicles would be met in Canada on a voluntary basis. These standards involve average fuel consumption targets being met separately for cars and "light trucks," averaged across each manufacturer's sales. With the agreements being renewed periodically, this has meant that Canada has essentially achieved fuel consumption improvements matching those under the U.S. mandatory standards. (In fact, Canadian fuel consumption has been slightly better in recent years, as Canadians have, on average, bought slightly lighter and smaller-engined vehicles than Americans.)

Extensive action has been taken by provincial and municipal governments to achieve greater fuel efficiency in transport. The 1970s and 1980s saw the introduction of a great variety of measures to encourage the use of public transport and discourage the use of private cars, including expansions of public transit networks and greater subsidization of their use; "park-and-ride" facilities; incentives for car-pooling; and traffic control and parking restrictions to limit use of private cars. In addition, incentives have been offered for using propane or compressed natural gas (conversion grants and lower excise taxes on the fuels), and many provinces and municipalities have converted some of their own vehicles to use these alternative fuels.

The federal government expects that substantial improvements in new motor-vehicle fuel consumption will continue to be made by manufacturers in the coming decades. *Canada's Green Plan*[28]

includes reconsideration of mandatory federal standards. A radical tightening of U.S. fuel efficiency standards is also under consideration (to an average of 40 miles per U.S. gallon for cars). In Canadian terms, this equates to 5.9 L/100 km — compared with the current voluntary standard for new vehicles of 8.6 L/100 km, and the average consumption of cars in use of about 12 L/100 km. Such improvements are feasible through a combination of increased engine efficiency and reduction in vehicle weight.[29]

It can also be anticipated that development of alternative fuels for motor vehicles will help to limit the use of gasoline and diesel fuel. Of the alternatives available in the immediate future, compressed natural gas offers the potential of up to a 20% reduction in CO_2 per unit of distance (over the whole cycle of production and use), while methanol offers less than 5% if produced from natural gas, and up to 100% if produced from biomass.[30] Some experts suggest that, in the long term, a transport system fuelled by electricity (produced without carbon fuels, by using hydro-electric, nuclear or solar energy) or fuelled by hydrogen will develop.[31] Such fuels would emit almost none of the pollutants and greenhouse gases. However, the prospects of this system developing on a large scale within the next 30 years or so remain very remote,[32] and the carbon-fuelled internal combustion engine will likely survive with little change for at least that period. In the interim, air pollutant and CO_2 emissions should be reduced substantially as vehicle fuel consumption improves, and it is likely also that greater use will be made of such alternative fuels as methanol, propane and natural gas, offering further reductions.

4.4 POTENTIAL CO_2 REDUCTION MEASURES

CCME has announced some initial steps toward setting sectoral goals, but has not yet agreed on programs. Its *National Action Strategy on Global Warming* suggests specific measures that might be pursued, including:

- replacing the use of fossil fuel in generating electricity by using nuclear, hydro-electric, wind, solar or tidal power;

- obtaining more efficient generation from fossil fuels, for example, by using "clean coal" technology or cogeneration;

- investing in conservation rather than generating capacity;

- applying "marginal cost and peak-load pricing" of electricity;

- increasing the use of mass transit, through restricting car access to city cores, raising parking fees, or charging urban highway tolls;

- improving traffic flows and reducing traffic densities through urban signal coordination, and so on; and

- promoting staggered working hours and working at home.[33]

The U.S. National Academy of Sciences study also includes an assessment of potential mitigation technologies.[34] Its conclusion is that decisions should be guided by the overall cost-effectiveness of the options, and it recommends that a substantial list of currently available technologies be adopted. The study concludes that this action could reduce U.S. greenhouse gas emissions by 10% to 40%, at relatively low costs or even at net savings.[35] It further states that options requiring great expense are not justified. It recommends moving toward "full-cost pricing" of energy.

5. POTENTIAL ROLE OF ECONOMIC INSTRUMENTS

Recent discussions of strategies for environmental protection, in Canada and elsewhere, give great prominence to the potential of applying pricing or using other market mechanisms (referred to more generally as "economic instruments") instead of, or in support of, regulations.[36] As well as specific pricing proposals, the CCME Strategy on CO_2 emphasizes the potential role for more general economic instruments such as carbon taxes or a carbon emissions trading system.[37] The *Green Plan* frequently mentions the potential for economic instruments, and recommends their development.[38]

Also, under the NO$_x$/VOC Management Plan, consideration is being given to introducing emissions trading programs within one non-attainment area, the Lower Fraser Valley.[39]

The main economic instruments of relevance are emissions charges and tradeable emissions permits.

5.1 EMISSIONS CHARGES[40]

5.1.1 Description

The most elegant form of emissions charging system would add the social costs imposed by the emissions to the price of any activity that produced them.[41] Those activities would then only be undertaken if participants obtained benefits that outweighed the social costs, and participants would also invest in controls that were cheaper than the alternative charges. Economists predict that, unless the type of environmental damage is so severe that it must be entirely eradicated, charging for its costs would be more efficient than regulating its reduction because charging would automatically lead to the least-cost pattern of abatement. To achieve the same result through regulation, the regulator would need to differentiate regulated limits for each class of polluters on the basis of the relative costs for pollution reduction. This would be complex, and regulators are unlikely to have the required information.

Furthermore, the social costs of damage could be incorporated into "benefit-cost" analyses of proposed system investments, to give appropriate weight to environmental concerns in comparisons of investments among modes (and between transport and other activities).

Thus, the simple prescription for achieving an efficient level of damage mitigation is to identify the costs imposed by the environmental damage that are attributable to each mode, and to incorporate them in user-charges.

5.1.2 Can Damage Costs be Estimated?

Many would counter that it is not possible to estimate costs for many aspects of damage, as does Environment Canada in its discussion paper on economic instruments.[42] The difficulties of determining costs have defeated most attempts to date, beyond some simple valuations of damages to materials or crops, when the damage is unequivocal and a market price can be referred to for its value. Two problems, respectively of science and economics, have proven intractable:

- identifying the damage caused by a unit of transport (passenger-kilometres/trip/mode); for example, by determining the extent to which people, plants and animals are harmed by transport emissions, noise or community disruption; and

- attributing money values to the damage.

It seems likely that scientific techniques will improve, though the medium-term prospects for improvements are limited, especially for quantification of the health effects. Some economists believe that there has been great progress recently in attributing money values for damage through such techniques as asking individuals what they would pay in hypothetical trading situations for improvements in environmental conditions.[43] When structured carefully, these experiments are impressive, and a growing body of social scientists finds them credible. While it might be credible, however, to use resulting values in cost-benefit analyses of control measures (in which analytical techniques can overcome experimental uncertainty), the hypothetical nature of these values would pose very substantial problems of public credibility if attempts were made to base prices on them.

It is also possible in some cases to estimate the costs of cleaning up environmental damage, which might provide a proxy for the social cost of the damage itself, and a basis for charging the polluters. In Europe, some public agencies charge companies for the treatment costs of chemical discharges into waterways.[44] It has been suggested

that the principle might be applicable to global warming damage, estimating the costs to mitigate flood damage from rising sea levels, for example (and possibly basing charges for CO_2 emissions on them). The principle, however, is by no means applicable to all types of environmental damage, as some types are completely irreversible (for example, the loss of a species), while for others, including air pollution, there are no clean-up options.

Problems of valuing noise damage are arguably less difficult than those for air pollution, because the sources and effects are easier to measure — particularly in the case of aircraft noise — and also because individual behaviour to avoid or accommodate noise is easier to measure. Nevertheless, considerable ingenuity is still required to infer values for noise, for example, from the effects of noise on house prices.[45]

5.1.3 Alternative Bases for Setting Emissions Charges

Costs to achieve pollution reduction targets: When national or international targets for pollution reduction are accepted, predictions of average reactions of transport users to changes in prices may indicate the level of emission charge that needs to be imposed to reach the goal. For example, it should be possible to examine the national NO_x goal and to infer the emissions surcharge on gasoline that would be needed to achieve the required reduction in that sector. It should also be possible to extend the analysis to consider what combinations of surcharges on the various fuels or engines might be needed throughout the transportation sector, and to do the same for all other sectors, in order to design a broad strategy.

While such an inferential procedure does not directly use the information available on the extent and value of environmental damage, this information will likely be assessed by policy makers in setting the national goals. The charges inferred to meet the goals would then also be based implicitly on that information.

Such inference of charges required to meet goals is the focus of much recent discussion of carbon taxes. Predictions of the reactions of industry and the public to such taxes in the United States have suggested that carbon taxes might need to be between about US$100/t and US$400/t of carbon to reach the Toronto Conference goal of 20% reduction in CO_2 by 2005.[46] Similar modelling in Canada has suggested that achieving the extra 15% reduction in CO_2 needed to meet the national stabilization goal in 2000 would necessitate a tax of about $120/t of carbon. This would amount to 7.7¢/L of gasoline, and 9¢/L of diesel fuel.

The appropriate goal for CO_2 reduction remains the subject of great debate, and of international negotiations.[47] Some economists reject the proposals for carbon taxing on the scale required to stabilize CO_2 emissions at 1990 levels, or to meet the Toronto Conference goal of a 20% reduction, arguing that it is not necessary at present to adopt an arbitrary goal that is expensive to meet. The U.S. studies mentioned earlier suggest that the annual costs of achieving the Toronto goal through carbon taxing would range from about 1% to 3% of gross national product. It can be argued that efforts might, at present, be better directed at defining more clearly the nature of the effects of global warming, and therefore the magnitude of the bene-fits to be gained from its control, and also at developing means to reduce emissions more cheaply in future.[48] Proponents of this view suggest that a modest carbon tax be introduced in the interim in order to steer behaviour toward conservation and substitution of energy use.

Resolving these differing judgements of the appropriate levels of charges requires enhanced understanding of the nature and costs of global warming, further objective analysis of the cost-effectiveness of control options, and careful modelling of producers' and consumers' reactions to charges in all relevant sectors of the economy.

Costs of damage implicit in previous regulatory decisions: Adoption by government of environmental damage regulations involves either explicit or implicit acceptance of its cost-effectiveness, in costs per unit of damage prevented. It can be inferred that the government believes the cost of the regulation per unit of damage prevented to be somewhat less than the social costs the damage would impose (otherwise they would prefer the damage). By extension, it could be argued that the implied unit cost of the regulation provides a minimum social cost to be used as a basis for setting charges for remaining emissions. This has been the argument used in Sweden, where a parliamentary agency endorsed the use as emissions charges of values per unit of emissions implicit in a previous decision to impose a motor-vehicle equipment regulation.[49]

An analogous inference could be made in Canada from the 1987 motor-vehicle emission standards, for example, that the cost per tonne of NO_x reduction was about $2,000.[50] If this is a reasonable charge for remaining NO_x emissions, it would imply a surcharge of about 0.12 cents per kilometre for cars, or 1 cent per litre of gasoline, and 0.74 cents per kilometre for heavy trucks, or about 1.2 cents per litre of diesel. Such charges should, of course, be extended logically beyond the transport sector.

5.2. TRADEABLE EMISSIONS PERMITS

5.2.1 Description[51]

The essence of a permit system is that the total amount of allowable emissions is determined in advance by the regulatory agency. Permits are then issued (donated or sold) only up to that limit, and they can be traded among emitters of pollution. The system is intended to introduce some flexibility compared with the customary regulatory procedure in which the emissions of every company are specified by the regulator. Under the permit system, if there are substantial differences in costs of meeting the standards among companies, one with high costs can effectively choose to pay a low-cost company to reduce emissions instead, by the device of buying the latter's permits. If the

high-cost company pays a price for the permits lower than its own costs of abatement but higher than those of the low-cost company, both companies are better off by the trade, as is the economy as a whole. The regulator's goal of the specified emissions limit is achieved, but at a lower cost than if the companies were required to abate equally.

If each company faces the same cost structure, there will be no trades, and if there are substantial costs in organizing trades, they might wipe out the potential gains. Alternatively, the scheme might be frustrated by low-cost firms refusing to trade, in order to gain a competitive advantage, or by high-cost firms choosing not to buy permits, to avoid public censure. In any of these cases, a permit scheme reverts to being a customary regulation. Therefore, permit schemes will, at worst, impose the same costs as regulations, and offer the prospect of achieving emissions reductions more cost-effectively.

5.2.2 Potential Relevance of Tradeable Permits to Transportation Emissions

No workable system of tradeable permits for individual transport vehicles has been designed. The flexibility of vehicle use, and therefore the unpredictability of their emissions in any specified time period, makes it difficult to envisage a permit system that is not also an administrative nightmare. For example, consider the case of NO_x emissions, which arise from many different types of processes, with major differences in the costs of abatement (for example, between pulp mills, power plants, passenger cars and diesel trucks). Cost-effectiveness comparisons show it could be cheaper for car drivers to pay for NO_x reductions in pulp mills than to obtain the equivalent reduction by buying Californian engine controls (or being forced to do so by a regulation).[52] But to address this with a permit system would require issuing and then monitoring trades in large numbers of permits for the very small amounts individuals would need (for example, an estimated vehicle-year's emissions or a vehicle-lifetime's emissions).

Alternatively, permits could be issued to vehicle manufacturers for their whole production fleet, allowing them to trade with other sources.[53] This would require manufacturers to take responsibility for the lifetime use of vehicles, so the requirements for monitoring by the regulatory agency (or the manufacturers) would still be stringent.

There would seem to be greater potential to design trading schemes that involved rail or air carriers, with fewer participants, and more predictable and monitorable emissions, but the payoff would not be great due to the relatively small total contributions of these modes to total emissions.

Some less ambitious variants of tradeable permits might be more feasible, and preferable to simple customary regulation in allowing more flexibility and lower compliance costs. An example might be to allow trading at least within an individual company. Rather than setting targets for each unit of production, a company-wide target would be set, and the company could meet the target however it pleased. Such corporate targets are the chosen means of regulating motor-vehicle fuel consumption, where the manufacturer meets a sales-weighted average consumption across all models, but, conspicuously, not for motor-vehicle emissions standards, in which each model must meet the same standard (in grams per kilometre). The government could obtain the same aggregate performance from each manufacturer with a corporate average emission rate, while allowing manufacturers the flexibility to achieve this at lowest cost by focussing on models in which abatement is cheaper (avoiding expensive re-design of old models, for example). Furthermore, if the target is expressed this way as an average emission rate (rather than total emissions from the vehicles concerned, with all the attendant problems of controlling vehicles over their lifetime), it becomes more reasonable to consider trading of those emissions rights among manufacturers. Companies producing predominantly cleaner (smaller) cars would sell their rights to those producing more-polluting (larger) ones.

5.3 EQUITY ISSUES IN ECONOMIC INSTRUMENTS

Environmental damage from transportation is arguably largely unfair, in that those harmed are usually not responsible, and are usually not compensated for damage. Furthermore, to the extent that regulations are inefficient through requiring the same emissions reduction (and its costs) to be borne by all, when the effects differ by location, those who do not travel in sensitive areas are unfairly penalized. Emissions charges that forced polluters to pay, and were differentiated by amounts of damage, would be fairer.

Emission charges, however, that were consistent across the modes — the same for each unit of pollutant — might pose some thorny equity questions. Current evidence suggests emissions are higher per passenger-kilometre by train than by car (discussed later in this chapter); therefore, charges per passenger would be higher for rail passengers than car passengers. It would be argued that such charges were regressive. Also, of course, the higher emissions for trains reflect current equipment and load factors, which rail passengers would be quick to claim were beyond their responsibility.

The equity implications of extending emissions charges to urban transportation would also be important. Charging car users for their emissions, through surcharges on gasoline taxes or registration fees, would be characterized as tax hikes, and viewed with suspicion because of their possibly regressive effects. In the case of poorer residents of our largest cities, if they were forced by circumstance to drive older, more-polluting cars, they would face surcharges higher than those in the surrounding areas, and higher than the average, and yet they would also be subject to the worst of the city environment themselves.

Similarly, introducing a carbon tax for CO_2 control would raise the question of its incidence by income group, and also by province or region, as its implications for electricity pricing became clear.

Finally, the emissions permit trading systems would have some equity implications, in apparently allowing permit buyers to meet lower pollution limits than permit sellers. (In other words, vehicle manufacturers might buy permits rather than reduce emissions in larger vehicles or older designs.) This might be perceived as unfair (though a strong counter-argument would be that such permit buyers are meeting the same standards, but choosing to do so by paying for emission reduction to be gained more cheaply elsewhere).

5.3.1 Uses of Revenues from Charges/Permits

As the charges would be payments for the social costs of environmental damage, Chapter 7 of Volume 1 of this report recommends that they should be paid to the government(s), rather than to the owners of the infrastructure (if separate agencies), and should not be used for system development. Charges might be used to pay for cleaning up the damage, in the limited cases where that is possible, or for compensating victims of damage, in the cases where they might be identifiable (which seems remote in the case of most air pollutants or for global warming). The remainder would probably constitute large amounts of new revenue to governments. There seems no compelling argument for earmarking these revenues for general use in environmental programs outside transport (as some environmental advocates have proposed).

6. ILLUSTRATIONS OF THE POSSIBLE COSTS OF DAMAGE FROM EMISSIONS AND OF THE POTENTIAL MAGNITUDE OF EMISSIONS CHARGES

Attempts are made later to illustrate the possible magnitude of costs of damage for each of the intercity passenger modes on a comparable basis. The system-wide averages per passenger-kilometre are provided, as are totals for two sample trips. It is supposed that the estimated damage costs could provide a basis for setting charges by mode.

The detailed design of environmental charges would be a complex effort, because the transfers of money involved on a national scale are potentially very large. The Royal Commission has not attempted the task, because the effects of possible charges on all damage sources would need to be predicted and judged, and these sources extend considerably beyond the transportation sector. This task should be undertaken by the departments of federal, provincial and territorial governments responsible for transport, environment, energy and finance.

All sources of environmental damage should be considered, possibly including disruption of social activities and other forms of "disamenity" experienced by those in proximity to transport facilities, as well as the more obvious forms of discharges and pollution. For the present, some hypothetical possibilities of charges are offered here based only on the damage from emissions of CO_2, NO_x and VOCs, together with aircraft noise, to illustrate the potential magnitude of surcharges, and how they might differ by mode. These are obviously not the only sources of environmental damage, but are possibly the most important, and are also those on which some scant information on possible costs is available.

Other components of emissions have been purposefully ignored. Carbon monoxide and particulate emissions are assumed irrelevant for intercity trips, as their damage is essentially urban, and SO_2 emissions from transportation are assumed to be so small a proportion of total national SO_2 emissions as to be negligible. These assumptions might prove incorrect when detailed design of potential charges was undertaken.

6.1 AVERAGE COSTS OF ENVIRONMENTAL DAMAGE FROM AIR POLLUTANTS AND CO_2 BY MODE

There are no convincing estimates of the average costs of environmental damage from CO_2, NO_x and VOCs. In preparing the Royal Commission's estimates of comprehensive costs by mode, it has

therefore been assumed that the charges necessary to achieve nationally declared goals for these emissions reflect the social value placed on preventing the damage. For CO_2, reviews were made of estimates in the United States and Canada of the prices that would be necessary to stabilize total CO_2 emissions from all sources at 1990 levels in 2000. In Canada, modelling has suggested that the necessary price is about $120/t of carbon, which is equivalent to $32.70/t of CO_2, or 3.27¢/kg (in 1991 dollars). This is used here as an estimate of the environmental damage from CO_2.

For NO_x and VOCs, no similar modelling appears to have been undertaken of the charges that might be sufficient to meet Canada's announced goals. At present, therefore, the charges can only be guessed to illustrate the costs and potential charges if the Royal Commission's recommendations are implemented. The task of making reliable estimates (or estimating damage losses from these emissions in some other manner) would be an initial priority in implementing the proposals.

The guesswork is guided by the NO_x/VOCs Management Plan, which produced some (very rough) estimates of the cost-effectiveness of a number of its proposed policies, in cost per tonne of emission prevented.[54] Measures considered acceptable in the Plan — various technological controls and limitations on activities — have an upper limit of cost of about $3,000 per tonne of either emission prevented (in 1989 prices). These measures in total are not sufficient to achieve Canada's recently announced goals for NO_x and VOCs reductions, so it can be deduced that to succeed in achieving them would require measures costing more than $3,000 per tonne. An initial guess is that such measures might cost $5,000 per tonne (in 1991 prices). (It is noted that measures are under consideration in the United States that would cost several times this amount per tonne of VOCs prevented.)[55] Then it can be suggested that the goals could alternatively be achieved through setting a price of that same amount of $5,000 per tonne, from rough reasoning that such a price would induce manufacturers and consumers to take advantage of all possible control measures

and behavioural changes that cost less than $5,000 per tonne. In support of these prices, it should be noted that the prices introduced in Sweden for NO_x and VOCs emissions amount apparently to about US$7,150 per tonne of NO_x and about US$3,550 per tonne of VOCs.[56]

Whether the prices for NO_x and VOCs should be equal in Canada should also be addressed in implementing the Royal Commission's proposals. For the present, it should be noted that the question of the relative contributions of the two types of emissions to low-level ozone formation in Canada's ozone-sensitive regions has not been definitively answered, though the NO_x/VOCs Management Plan suggests pursuing both NO_x and VOCs reductions with equal urgency. The Plan also implicitly endorses an equal value for damage in proposing the adoption of measures with the same upper limit on cost-effectiveness per tonne. For illustrative purposes, the value of $5,000 per tonne ($5 per kilogram) is used in the Royal Commission's costing for both NO_x and VOCs.

It must also be decided whether the damage costs and any prices that emerge from these costings apply equally throughout Canada. It is clear from Environment Canada and CCME decisions that the effects of low-level ozone are considered much worse within the three ozone-sensitive regions now designated as requiring special attention — the Lower Fraser Valley, Windsor to Quebec City corridor and southeastern New Brunswick. It is assumed for illustrative purposes that the costs of damage arise from emissions of NO_x and VOCs only in those regions. Estimates must therefore be made of the proportions of total emissions by mode that arise within the sensitive regions. From the Canadian Travel Survey for 1988, it was reported that about 70% of the car-kilometres in long-distance trips were driven within the provinces of British Columbia, Ontario, Quebec and New Brunswick. It is guessed that the proportion of that travel, and its fuel and emissions, within the ozone-sensitive regions was around 70%, so about 50% (70% of 70%) of national intercity car traffic was within those regions. The damage cost of $5,000 per

tonne of NO_x and VOCs is therefore applied to 50% of the average national emissions by car per passenger-kilometre. Similarly, the proportions of bus and train fuel use and emissions within the sensitive regions are guessed to also be 50%, while that of aviation emissions is guessed at 20%. (The average NO_x and VOCs emissions from aircraft are low relative to the other modes and also relative to aircraft CO_2 emissions, so the margin of error in the final estimate of the damage costs for aircraft is relatively unimportant.) For ferries, it is assumed that none of the emissions are within the sensitive regions (which ignores ferry contributions to problems in southern British Columbia and around Saint John, New Brunswick).

Furthermore, the focus must be on those periods when the emissions are most damaging. Concentrations of ozone exceeding the maximum acceptable NAAQO occur primarily in the summer months, in episodes lasting a few hours or days. It is assumed that charging $5,000 per tonne for NO_x and VOCs only during the summer season would prompt adoption of measures that achieve the goals. Costs are therefore counted only for the emissions in that season. Monthly counts from the Canadian observation stations of episodes in which ozone exceeds the maximum acceptable NAAQO show that they are concentrated in the months of May to August.[57] The target season for ozone charges is therefore defined as May to August. Within those four months, it is assumed (based roughly on fuel sales by month) that emissions in each mode account for 40% of the annual total.

Finally, applying the above values of $32.70 per tonne of CO_2, and $5,000 per tonne of NO_x or VOCs within the ozone-sensitive regions, to 40% (summertime proportion) of the emissions per passenger-kilometre by mode in Table 7(2)-3, the following system-wide average costs of emissions per passenger-kilometre by mode are obtained (and used in the system-wide average costing in Volume 1, Chapter 3 of this report).

Table 7(2)-7

ESTIMATED COSTS OF SYSTEM-WIDE, YEAR-ROUND EMISSIONS PER PASSENGER-KILOMETRE (1991 CENTS PER PASSENGER-KILOMETRE)

Mode	CO_2	NO_x/VOCs	Combined
Bus	0.169	0.077	0.246
Car	0.410	0.166	0.577
Train	0.382	0.259	0.642
Airplane	0.899	0.022	0.921
Ferry	1.972	0.000	1.972

6.2 ILLUSTRATION OF POTENTIAL MAGNITUDE OF EMISSIONS CHARGES FOR SAMPLE ROUTES

The examples used in Volume 1, Chapter 7 are for the trips from Toronto to Montreal and Saskatoon to Halifax. To estimate the environmental damage, the first step is to estimate the amounts of emissions by mode for each of the trips. The emissions per unit of fuel energy used in each mode are expected to remain as shown in Table 7(2)-1, but the emissions per passenger-kilometre are expected to differ from the system-wide averages shown in Table 7(2)-3 because equipment and load factors vary by route for the public modes, and so, therefore, do the amounts of fuel used per passenger-kilometre. Royal Commission staff estimates of the amount of fuel required per passenger-trip (consistent with the vehicle/carrier costing elsewhere in this report) are shown in Table 7(2)-8.

Table 7(2)-8

FUEL USE PER PASSENGER-TRIP BY MODE, FOR SAMPLE ROUTES (LITRES/PASSENGER-TRIP)

Mode	Toronto to Montreal	Saskatoon to Halifax
Bus	5.9	67
Car	28.9	240
Train	15.0	283
Airplane	40.8	219

Multiplying the energy used in megajoules per passenger-kilometre (using values from Table 7(2)-2) by the ratios of emissions to energy use by mode (in Table 7(2)-1) provides measures of the emissions of CO_2, NO_x and VOCs per passenger-kilometre. These values are shown in Table 7(2)-9, for the two sample routes. (This table appears in a slightly different form in Chapter 7 of Volume 1 as Table 7-1.)

Table 7(2)-9
EMISSIONS PER PASSENGER-KILOMETRE (GRAMS)

Toronto to Montreal							
					If all seats filled		
	Car	Bus	Train	Airplane	Bus	Train	Airplane
CO	5.20	0.18	0.34	0.17	0.14	0.21	0.11
VOCs	0.94	0.05	0.14	0.10	0.04	0.09	0.07
NO_x	0.75	0.40	1.54	0.34	0.31	0.96	0.23
CO_2	128.0	30.0	76.0	220.0	23.0	47.0	148.0
Load factor		0.77	0.62	0.675	1.00	1.00	1.00
Saskatoon to Halifax							
					If all seats filled		
	Car	Bus	Train	Airplane	Bus	Train	Airplane
CO	5.20	0.24	0.77	0.13	0.14	0.54	0.09
VOCs	0.94	0.07	0.32	0.08	0.04	0.23	0.05
NO_x	0.75	0.54	3.52	0.26	0.31	2.46	0.17
CO_2	128.0	41.0	173.0	167.0	23.0	121.0	113.0
Load factor		0.57	0.7	0.675	1.00	1.00	1.00

Sources: Emissions per unit fuel from VHB Research & Consulting, "Environmental Damage from Transportation." Fuel consumption per pass-km estimated by Royal Commission staff.

As noted, the emissions rates depend on the assumed load factors of the public modes, shown for each route in the final row of Table 7(2)-9. To show the importance of the load factors, the table also shows the potential emissions per passenger-kilometre if all seats were filled. No load factor for cars is shown, but the assumed car occupancy of about 1.8 implies a load factor of only 35%. Filling all car seats could then potentially reduce car emissions per passenger-kilometre by about 65%.

To estimate the damage costs, and potential emissions charges to recuperate them, the total emissions per passenger-trip are estimated, as shown in Table 7(2)-10. The table indicates the trip distances by mode, and total emissions of CO_2, NO_x and VOCs per passenger-trip. However, as discussed, the emissions of the ozone precursors, NO_x and VOCs, are assumed to produce damage only when released in the ozone non-attainment areas. The table therefore indicates the distance by each mode that is assumed to take place within such areas. For the Toronto to Montreal trip, all of the surface routes are within the Windsor to Quebec City corridor, while for the Saskatoon to Halifax trip, only those parts of the trip within that ozone non-attainment area and the one in southeastern New Brunswick are included.

Table 7(2)-10
EMISSIONS PER PASSENGER-TRIP (GRAMS)

			Toronto to Montreal				
		km in ozone-sensitive areas	Total emissions			In sensitive regions	
	km		CO_2	NO_x	VOCs	NO_x	VOCs
Car	539	539	68,933	406	508	406	508
Bus	539	539	16,243	215	28	215	28
Train	540	540	41,027	833	77	833	77
Airplane	496	340	108,902	169	52	116	35
			Saskatoon to Halifax				
		km in ozone-sensitive areas	Total emissions			In sensitive regions	
	km		CO_2	NO_x	VOCs	NO_x	VOCs
Car	4,485	650	573,586	3,380	4,225	490	612
Bus	4,485	650	183,522	2,431	312	352	45
Train	4,468	400	774,859	15,724	1,449	1,408	130
Airplane	3,500	559	585,081	906	277	145	44

Sources: Emissions per unit fuel from VHB Research & Consulting, "Environmental Damage from Transportation." Fuel consumption per pass-km and route distances estimated by Royal Commission staff.

For the airplane trips, it is assumed that the emissions at cruising height are too high to contribute to low-level ozone concentrations. An estimate of the emissions that do contribute to low-level ozone is

obtained using the constant term from the fuel consumption equation used in the air carrier costing model. Approximately 35 L per aircraft trip is constant over a trip of any distance, contributing to low-level ozone through climbing, descending, taxiing and idling. The figures in Table 7(2)-10 for airplane-trip "kilometres in ozone-sensitive zones" are obtained by expressing 35 L as a proportion of total fuel used per passenger-trip, and multiplying this by total trip distance.

The illustrative emissions charges are then obtained by multiplying the CO_2 emissions in Table 7(2)-10 by 3.27¢/kg, and the NO_x and VOCs emissions in the sensitive regions by $5/kg. The results are shown in Table 7(2)-11, which appears (with rounded values) as Tables 7-2 and 7-3 in Volume 1, Chapter 7.

Table 7(2)-11
ILLUSTRATIVE EMISSIONS CHARGES (DOLLARS PER PERSON-TRIP)

	Toronto to Montreal			
	Winter	Summer		
	CO_2 charge	CO_2 charge	NO_x/VOCs charge	Total charge
Car	2.25	2.25	4.57	6.82
Bus	0.53	0.53	1.21	1.75
Train	1.34	1.34	4.55	5.89
Airplane	3.56	3.56	0.76	4.32
	Saskatoon to Halifax			
	Winter	Summer		
	CO_2 charge	CO_2 charge	NO_x/VOCs charge	Total charge
Car	18.76	18.76	5.51	24.27
Bus	6.00	6.00	1.99	7.99
Train	25.34	25.34	7.69	33.03
Airplane	19.13	19.13	0.94	20.08

Source: Royal Commission staff estimates. See text.

6.3 ESTIMATES OF ENERGY USE AND EMISSIONS BY HIGH-SPEED RAIL

The estimates of possible emission charges for high-speed trains in Volume 1, Chapter 7 of the report are based on the following analysis.

6.3.1 Energy Use

Estimates of the energy requirement for a service like the "train à grande vitesse" (TGV), operating in the Windsor to Quebec City corridor (at 300 km/h), are available as follows:

The power required from the electricity grid into the rail system is estimated by Lake et al. as:[58]

- 0.083 kilowatt-hours (kWh) per passenger-kilometre,

- where 1.0 kWh equals 3.6 MJ.

In other words, the service would require 300 kJ of energy per passenger-kilometre.[59]

Khan's report[60] quotes Johnson et al.[61] for an estimate of the power required from the electricity grid as:

- 275 kJ/seat-kilometre.

The estimated average train occupancy on the proposed Toronto to Montreal route is:

- 75%.

This means that:

- 370 kJ of energy per passenger-kilometre would be used.

Khan also considers the source of the electricity. He estimates that the combined electricity output of Ontario and Quebec is provided approximately 55% by hydro-electricity plants and 45% by thermal (including nuclear) plants. He suggests that of the "primary" fuel used for the thermal plants, 3.6% is required to process and transport the fuel to generating plants, and up to 70% is lost in the generation process. For either thermal or hydro-electricity, he suggests 15% of power supplied by the plants is lost in transmission and delivery within the rail system. In sum, he estimates that, on average in the two provinces, only 55% of "primary" energy (electricity from the hydro plants, or initial fuel for thermal plants) reaches the trains. Therefore he suggests that the 275 kJ/seat-kilometre in "secondary" energy requires (275/0.55 =) 500 kJ/seat-kilometre in "primary" energy. Using his 75% average train occupancy, this equals an energy requirement of 670 kJ/per passenger-kilometre.

The report of the Ontario/Quebec Rapid Train Task Force[62] quotes estimates made by Ontario's Ministry of Transportation of "overall energy efficiency" of current modes and future options for high-speed rail and magnetic levitation (maglev) trains, including the following kilowatt-hours per passenger-kilometre for the 300 km/h TGV Atlantique or ICE in a Windsor to Quebec City corridor service.[63] The final column converts these to kilojoules per passenger-kilometre.

	kWh/pass-km	kJ/pass-km
Windsor to Toronto	0.10–0.12	360–430
Toronto to Montreal	0.09–0.11	320–400
Montreal to Quebec City	0.11–0.13	400–470

It is not clear whether these estimates refer to "secondary" or "primary" power requirements, but it seems likely they are the power requirements of the rail system from the electricity grid.

6.3.2 Synthesis

These estimates lie in the range of 300 to 470 kJ/pass-km for all of the corridor services. For the Toronto to Montreal route, the estimates are 300 kJ/passenger-kilometre from Lake et al., 370 kJ/pass-km from Khan, and the range of 320 to 400 kJ/pass-km from the Ontario/Quebec Rapid Train Task Force. An approximate mean of this range, for the purpose of showing the possible magnitudes of energy and emissions from high-speed trains relative to current modes, is 350 kJ/passenger-kilometre.

To the extent that the electricity was provided from fossil-fuel-fired plants, a conversion from "secondary" energy requirements to "primary" requirements is necessary, along the lines suggested by Khan. Khan's estimates of the average losses of energy in generation, however, are probably too pessimistic in their assumption that about 75% of Ontario's power comes from thermal stations with average conversion efficiency of 30%. For the present main purpose of comparing emissions from high-speed trains with those from other modes, the prime interest is in the amount of fossil fuel that might be used to generate the electricity. The conversion efficiency is only of relevance to the extent that the high-speed rail system would be supplied from fossil-fuel-fired plants. The current contribution of such plants in Ontario and Quebec is shown in Table 7(2)-12.

Table 7(2)-12
SOURCES OF ELECTRIC POWER GENERATION IN ONTARIO AND QUEBEC, 1991

Source	Ontario		Quebec	
	(GWh)	(%)	(GWh)	(%)
Hydro	37,441	26.6	137,867	97.1
Conventional steam	31,483	22.4	264	0.2
Nuclear	70,773	50.3	3,910	2.7
Other	1,001	0.7	(negligible)	
Total	140,698	100.0	142,041	100.0

Source: Statistics Canada, Catalogue No. 57-001.

The "conventional steam" plants and the "other" plants in Ontario are fired by fossil fuels. Of the combined total for the two provinces, therefore, these provided some 11.6% of electricity generated in 1991. This proportion can be expected to decrease in the future, if plans are implemented in Quebec to increase its hydro-electric output and in Ontario to increase its nuclear output.[64]

The extent to which a high-speed rail system would in practice draw on the fossil-fuel-fired plants would depend on the production conditions at the time its demands were made. For certain trains at peak electricity demand times, it is possible that all of the marginal power used would be generated by the fossil-fuel-fired plants, while for others at off-peak times the marginal power would come entirely from hydro-electric or nuclear plants. For a simple illustration of the potential emissions, no attempt is made to predict the exact outcome, but the simple assumption is made that a high-speed rail system at the end of the current decade would draw from the electricity grids of Ontario and Quebec in an average manner. It could then be expected to receive about 10% of its electricity from fossil fuels. Recognizing that losses in generation in fossil-fuel-fired plants amount to 50% to 70% of total energy input, the "primary" fuel requirement to those generation stations can be estimated conservatively to be of the order of double the above rate per passenger-kilometre, or about 700 kJ/pass-km. The illustrations of potential emissions from high-speed rail that follow use these average assumptions: 10% of the electricity required for the trains is generated using fossil fuels, at an average energy intensity of 700 kJ/pass-km.[65]

6.3.3 Emissions

For comparisons with the environmental costs of other modes, all of the environmental impacts expected from each should be strictly accounted for. Due to the uncertainties of damage cost estimation, the cost analyses by mode are limited to those effects expected to be of most importance from intercity passenger transportation: the emissions of CO_2, NO_x and VOCs. When considering the case of high-speed rail, only costs for emissions of CO_2 and air pollutants

are shown, so only the fossil-fuel-fired portion of the electricity used is relevant. No costs are added for the other potentially important categories of environmental effects from hydro-electricity plants and nuclear generating stations.

The emissions of interest and importance from fossil-fuel-fired plants are CO_2, NO_x and also SO_2. Sulphur dioxide is important because it damages health by aggravating respiratory complaints such as asthma and bronchitis, and because of its major contribution to acid rain. While SO_2 is produced in all combustion processes, the amounts created from fuel use by current intercity passenger transportation are considered sufficiently small, and their emissions sufficiently remote from sensitive populations, that no cost was assigned to them in the cost analyses in the earlier sections. However, the SO_2 from fossil-fuel-fired electricity plants is of sufficient importance that an attempt should be made to assign a cost to it, as has been done with NO_x and VOCs.

Table 7(2)-13 shows the main components of the cost analysis:

Column 1 illustrates the emissions per unit of energy used in these plants:

- Emissions of CO_2 can be estimated from the carbon content of coal (assuming Canadian bituminous coal is used in power plants) as 92.1 g/MJ.[66]

- Emissions of NO_x and SO_2 can be estimated from average rates forecast by Ontario Hydro for 1996 to 2000,[67] of 1.612 g/kWh of NO_x, and 4.0 g/kWh of SO_2. These convert to 0.448 g/MJ of NO_x and 1.11 g/MJ of SO_2.

Column 2 shows the estimated energy requirement from fossil-fuel-fired plants of 700 kJ per passenger-kilometre.

Column 3 lists the grams of emissions per passenger-kilometre, which is the product of the previous two columns.

Column 4 shows the estimated costs per tonne of emissions. The amounts for CO_2 and NO_x are as used throughout this environmental cost analysis, from amounts assumed to be necessary to meet national goals, of \$120 per tonne carbon, or \$32.70 per tonne CO_2, and \$5,000 per tonne NO_x, when emitted in summer. The estimated cost of SO_2 is obtained from the report by VHB for the Royal Commission,[68] derived in turn from a review of cost estimates by Ottinger et al.[69] The cost is quoted as \$5.29/kg in 1989 prices, which is inflated to 1991 prices, and converted to an estimate of \$6,000 per tonne.

Column 5 estimates the costs in cents per passenger-kilometre, obtained as the product of columns 3 and 4.

Table 7(2)-13
COSTS OF EMISSIONS FROM FOSSIL-FUEL-FIRED ELECTRICITY PLANTS, FOR HIGH-SPEED RAIL (1991 PRICES)

	g/MJ	kJ/pass-km	g/pass-km		Cost (\$/tonne)	Cost (¢/pass-km)
CO_2	92.10	700	64.50		33	0.21
NO_x	0.45	700	0.31	summer	5,000	0.16
				other seasons	0	0.00
SO_2	1.11	700	0.78		6,000	0.47
Total					summer	0.84
					other seasons	0.68
					average	0.74[a]

a.   Assuming summer emissions are 40% of the annual total.

The emissions costs are thus estimated to range between zero, when the electricity is generated from non-fossil sources, to about 0.73 cents per passenger-kilometre when the electricity is entirely from fossil fuel. Then it remains to estimate average costs per passenger-kilometre for electricity used in high-speed rail, given the proportion of the power to be provided by fossil-fuel-fired plants. As noted earlier, the assumption is made that this proportion will, on average, be the same as the contribution of fossil-fuel-fired plants to total electricity generated in Ontario and Quebec: about 10%. The final estimated costs of the emissions from high-speed rail are therefore approximately

(10% of 0.84¢ =) 0.08¢/pass-km in summer, and 0.07¢/pass-km in the rest of the year. A rounded estimate of the year-round average, with about 40% of fuel use in summer, would be 0.07¢/pass-km.

6.4 ESTIMATES OF AIRCRAFT NOISE COSTS

Costs for aircraft noise are included in the system-wide costs and costs for sample routes in Chapters 3 and 18 of Volume 1 of this report, based on the following information.

Estimates of the costs of noise at Toronto and Vancouver airports are obtained from Gillen and Levesque.[70] The authors infer values of noise nuisance from those airports, and estimate noise costs for various models of aircraft. Their findings imply that there are sub-stantially greater costs for "Stage 2" aircraft than for those with "Stage 3" noise controls. For example, the cost per movement for a B767-200 is $89 at Lester B. Pearson International Airport in Toronto compared with $123 for a B737-200 and $138 for a DC9-30. The costs are somewhat different at Vancouver from those at Pearson, and no simple averages for all types of aircraft are presented. For purposes of illustration, however, only orders of magnitude are necessary, and it is apparent from the tables that the cost per seat-movement is somewhat above $1.00 for the older aircraft, and below $0.50 for the newer models. Taking average occupancies into account, it will be assumed that it is reasonable to represent noise costs at these two airports as $1.00 per person-movement, in round figures (a figure somewhat higher than the source tables would suggest).

Then it is assumed that similar noise costs hold at Montreal's Dorval Airport, but that noise costs are otherwise negligible at Canadian air-ports. (This is not realistic but possibly counters the overstatement of costs at the main airports.) These three major airports account for 60% of total enplaned/deplaned passengers in Canada (including international passengers). It is therefore assumed that noise costs are, in very rounded figures, closer to $0.50 per passenger-movement

nation-wide, or $1.00 per passenger-trip. This cost is included in the estimates of system-average environmental damage costs in Volume 1, Chapter 3 of this report, and for the costs of the sample routes, the costs are assumed to occur only at the major three airports, as $1.00 per passenger-movement.

ENDNOTES

1. VHB Research & Consulting, "Environmental Damage from Transportation," in Volume 4 of this report.

2. William A. Sims, "Externality Pricing," a report prepared for the Royal Commission on National Passenger Transportation, RR-07, Oct. 1991.

3. Government of Canada, *Economic Instruments for Environmental Protection*. Cat. No. En21-119/1992/E (Ottawa: Supply and Services Canada, 1992).

4. The following is drawn from the report by VHB Research & Consulting, "Environmental Damage," section 4.2, and from Transport Canada/Environment Canada, *A Plan to Identify and Assess Emission Reduction Opportunities from Transportation, Industrial Engines and Motor Fuels*, Report TP 9773 (Ottawa: Transport Canada, May 1989).

5. See C. Johnson, J. Henshaw and G. McInnes, "Impact of Aircraft and Surface Emissions of Nitrogen Oxides on Tropospheric Ozone and Global Warming," *Nature* 355 (Jan. 1992), pp. 69–71; and M. Barrett, *Aircraft Pollution, Environmental Impacts and Future Solutions*, World Wildlife Fund, Aug. 1991.

6. VHB Research & Consulting, "Environmental Damage," Table 4.

7. The estimate of pass-km per litre for ferries might be underestimated as fuel use is allocated between passenger and freight traffic according to deck space used, with no allowance for any effect of vehicle loads on fuel consumption. If weight were the only determinant, passengers and their vehicles would be responsible for much less fuel use, and the estimate of pass-km per litre in the table might rise by 50% or so. Information on vehicle loads is not available, but it is believed that they are of only minor additional importance to fuel consumption once use of deck space is allowed for.

8. This section is drawn particularly from VHB Research & Consulting, "Environmental Damage," Section 4.2.5.

9. For definitions of NAAQOs see Environment Canada, Inventory Management Division, Conservation and Protection, *National Urban Air Quality Trends 1978-1987*, Report EPS 7/UP/3 (Ottawa, May 1990), p. 6.

10. Ibid., Sections 4, 3 and 6.

11. Ibid., Section 5.

12. A summary of health effects is contained in D. V. Bates, "Adverse Health Effects of Automobile Emissions," unpublished paper presented to the Royal Commission on National Passenger Transportation Technical Seminar on Transportation and the Environment, Sept. 1991.

13. VHB Research & Consulting, "Environmental Damage."

14. Ontario Ministry of the Environment, *Ozone Effects on Crops in Ontario and Related Monetary Values*, Report ARB-13-84 (Toronto, 1984).

15. Transport Canada/Environment Canada, *A Plan to Identify*, p. 10.

16. Intergovernmental Panel on Climate Change, *Policy Makers Summary of the Scientific Assessment of Climate Change: Report to the IPCC from Working Group I*, United Nations Environment Programme, June 1990.

17. Predictions excerpted from Canadian Council of Ministers of the Environment (CCME), *National Action Strategy on Global Warming*, Nov. 1990, p. 4.

18. U.S. National Academy of Sciences, National Academy of Engineering, Institute of Medicine, *Policy Implications of Greenhouse Warming* (Washington, D.C.: National Academy Press, 1991).

19. W. D. Nordhaus, "To Slow or Not to Slow: The Economics of the Greenhouse Effect," (New Haven, CT: Yale University, Feb. 1990) (mimeograph); or see W. D. Nordhaus, "A Sketch of the Economics of the Greenhouse Effect," *American Economic Review Papers and Proceedings of the 103rd Annual Meeting*, May 1991, pp. 146-150.

20. See Transport Canada/Environment Canada, *A Plan to Identify*, for descriptions of proposals.

21. CCME, *Management Plan for Nitrogen Oxides (NO$_x$ and Volatile Organic Compounds (VOCs), Phase I*, CCME-EPC/TRE-31E, Nov. 1990.

22. Ibid., Appendix A.

23. Ibid., Table 20, p. 153.

24. Ibid., pp. 148–52.

25. The following notes rely heavily on CCME, *National Action Strategy on Global Warming*.

26. National Energy Board, *Canadian Energy Supply and Demand 1990–2010*, Cat. No. NE23-15/1991 (Ottawa: Supply and Services Canada, 1991).

27. United Nations, *Framework Convention on Climate Change* (New York, N.Y.: UN, May 1992).

28. Environment Canada, *Canada's Green Plan for a Healthy Environment,* Cat. No. En21-94/1990 (Ottawa: Supply and Services Canada, 1990).

29. See P. Reilly-Roe, "Assessment of Transportation Energy Technologies to 2020," Transportation Energy Division, Energy, Mines and Resources Canada, 1991 (unpublished mimeograph); and V. C. Battista, D. Boucher and E. R. Welbourne, "A Preliminary Review of Options for Reducing Emissions of Carbon Dioxide from Motor Vehicles," Technical Memorandum TMVS 9101, unpublished, Road Safety Directorate, Transport Canada, Jan. 1991.

30. Battista et al., "A Preliminary Review," pp. 34–40. The report suggests methanol from biomass would have essentially no net CO_2 emissions as it would initially fix atmospheric CO_2 and subsequently release it.

31. See R. F. Webb, "Alternative Fuels: Prospects and Effects," unpublished paper presented to the Royal Commission on National Passenger Transportation Technical Seminar on Transportation and the Environment, Sept. 1991.

32. We note that some U.S. states, starting with California, intend to require that manufacturers begin to supply vehicles with very low emissions (which initially means electric vehicles) within this decade.

33. CCME, *National Action Strategy on Global Warming*.

34. U.S. National Academy of Sciences, *Policy Implications*; and *Policy Implications of Greenhouse Warming, Report of the Mitigation Panel* (Washington, D.C.: National Academy Press, 1991).

35. The report's suggestion that consumers are uninformed or irrational in failing to adopt such cost-reducing technologies as compact fluorescent lightbulbs is challenged in W. D. Montgomery, *The Cost of Controlling Carbon Dioxide Emissions, Final Report*, Report CRA 858.00 (Washington, D.C.: Charles River Associates Incorporated, Dec. 1991). Montgomery suggests the alternative interpretation that consumers' rejection of such technology demonstrates that the NAS analysis understates the private costs or overstates the private benefits.

36. See for example, Environment Canada, *Economic Instruments for Environmental Protection*; Organisation for Economic Co-operation and Development (OECD), *Economic Instruments for Environmental Protection* (Paris: OECD, 1989); and more generally W. J. Baumol and W. E. Oates, *The Theory of Environmental Policy*, 2nd ed. (Cambridge, U.K.: Cambridge University Press, 1988).

37. CCME, *National Action Strategy on Global Warming*, section 8.2.1.

38. Environment Canada: *Canada's Green Plan*, pp. 156–8.

39. CCME, Emission Trading Working Group, *Emission Trading, A Discussion Paper*, CCME, May 1992.

40. For a detailed discussion see Sims, "Externality Pricing."

41. Strictly prices would need to be equal everywhere to social marginal cost.

42. Environment Canada, *Economic Instruments for Environmental Protection*.

43. See in particular: D. W. Pearce and A. Markyanda, *Environmental Policy Benefits: Monetary Valuation* (Paris: OECD, 1989); D. W. Pearce and R. K. Turner, *Economics of Natural Resources and the Environment* (Baltimore, MD: Johns Hopkins University Press, 1990); and VHB Research & Consulting, *Environmental Damage*, Sections 3.3 and 7.

44. OECD, *Economic Instruments*, Chapters 3 and 4.

45. See for example, D. W. Gillen and T. J. Levesque, *The Management of Airport Noise*, Report TP 10118 (Ottawa: Transport Canada, Transportation Development Centre, July 1990); and D. W. Gillen and T. J. Levesque, "Measuring the Noise Costs of Alternative Runway Expansion at LBPIA Using Residential Housing Markets," report prepared for Transport Canada, Major Crown Projects, Apr. 1991.

46. See J. A. Edmunds and J. M. Reilly, "Global Energy and CO_2 to the Year 2050," *The Energy Journal* 4 (1983), pp. 21–47; A. S. Manne and R. G. Richels, "Global CO_2 Emission Reductions: The Impact of Rising Energy Costs," *The Energy Journal* 12, 1 (1991), pp. 87–107; W. D. Nordhaus, "The Cost of Slowing Climate Change: a Survey," *The Energy Journal* 12, 1 (1991), pp. 37–65; D. W. Jorgensen and P. J. Wilcoxen, "The Cost of Controlling U.S. Carbon Dioxide Emissions," in *Proceedings of the Workshop on Economic/Energy/Environmental Modelling for Climate Policy Analysis*, eds. D. O. Wood and Y. Kaya (Cambridge, Mass.: MIT Center for Energy Policy Research, Jan. 1991); and U.S. Congressional Budget Office, *Carbon Charges as a Response to Global Warming: The Effects of Taxing Fossil Fuels* (Washington, D.C.: CBO, August 1990). For summaries and interpretations, see W. R. Cline, "Economic Models of Carbon Reduction Costs: An Analytical Survey," Harvard University Institute for International Economics, June 1991 (mimeograph); and Montgomery, *The Cost of Controlling*.

47. See M. Grubb, *The Greenhouse Effect: Negotiating Targets* (London, U.K.: Royal Institute of International Affairs, 1989).

48. Montgomery, *The Cost of Controlling*.

49. L. Hansson, "Air Pollution Fees and Taxes in Sweden," paper presented to 70th Annual Meeting of the Transportation Research Board, Washington, D.C., Jan. 1991.

50. J. J. Lawson, *Analysis of the Effects of Proposed Revisions to Light Motor Vehicle Emission Standards*, Report TP 6684 (Ottawa: Transport Canada, Road Safety Directorate, June 1985).

51. See T. H. Tietenberg, *Emissions Trading: An Exercise in Reforming Pollution Policy* (Washington, D.C.: Resources for the Future Inc., 1985); and discussions in Sims, "Externality Pricing"; Environment Canada, *Economic Instruments for Environmental Protection*; and A. J. Krupnick, "Vehicle Emissions, Urban Air Quality, and Clean Air Policy," discussion paper QE91-15 (Washington, D.C.: Resources for the Future, July 1991).

52. See Lawson, *Analysis of the Effects* and other comparisons of cost-effectiveness of control options in Krupnick, "Vehicle Emissions."

53. As proposed in B. K. Stevens, "A Tradeable Vehicle and Fuel Credits Program," paper presented to the (U.S.) Western Economic Association International Conference, 1991.

54. CCME, *Management Plan for Nitrogen Oxides and Volatile Organic Compounds, Phase I*, Tables 24 and 25, pp. 168–9.

55. Krupnick, "Vehicle Emissions," Table 2, p. 20.

56. Oral presentation by Lars Hansson, "Political problems of implementing emission and congestion pricing in Sweden," Session 198, Transportation Research Board 71st Annual Meeting, Washington, D.C., Jan. 1992.

57. From information provided to the Commission by Mr. T. Dann, Head Air Toxics Section, Technology Development Branch, Conservation and Protection, Environment Canada, Ottawa, dated May 25, 1992. Average "total station episode-days" by month during 1987-1989 were as follows (where an episode is one or more hours with ozone concentration greater than 81 ppb):

Month	Episode-Days
April	6
May	103
June	222
July	311
August	166
September	32
October	10

58. R. W. Lake et al., *Alternative to Air: A Feasible Concept for the Toronto–Ottawa–Montreal Corridor* (Kingston: Queen's University, CIGGT, 1980).

59. It can also be deduced from the report that reaching peak speed of 300 km/h rather than 260 km/h, a 15% increase in speed, requires 25% more energy.

60. A. M. Khan, *Energy and Environmental Factors in Intercity Passenger Transportation*, Report TP 10198 (Ottawa: Economic Analysis Division, Transport Canada, 1990).

61. L. R. Johnson et al., *Maglev Vehicles and Superconductor Technology: Integration of High-Speed Ground Transportation into the Air Travel System*, Argonne National Laboratory Report ANL/CNSV-67, Apr. 1989.

62. Dessau Inc., *A Review of the Environmental Impact of Investment in High-Speed Rail in the Ontario-Quebec Corridor: Final Report*, Ontario/Quebec Rapid Train Task Force (Aug. 1990).

63. This report also provides a range of estimates of energy use for a 200km/h service (British Rail HST, Amtrak Turboliner, or PCH Turboliner), of 220 kJ/pass-km to 400 kJ/pass-km.

64. See Ontario Hydro, *Submission to the National Energy Board, in the matter of an application by Ontario Hydro for export permits pursuant to Division II of the Act, Volume 4, Social Cost Studies* (Toronto: Ontario Hydro, Oct. 1990).

65. Some further support for this estimate is provided by T. Lynch, "Maglev and High Speed Rail System Environmental Energy and Economic Benefit Evaluation in Florida: A Comparative Analysis," in *Magnetic Levitation Technology and Transportation Strategies*, Report SP-834 (Warrendale, P.A.: Society of Automotive Engineers, Aug. 1990). This suggested the TGV-type train would use about 250 kJ/pass-km in "net" energy, or 750 kJ/pass-km in "gross" energy from thermal stations.

66. From A. P. Jaques, *National Inventory of Sources and Emissions of Carbon Dioxide (1987)*, Report EPS 5/AP/2 (Ottawa: Environment Canada, 1987), Table S.3. This average might understate average emissions from coal plants, as lignite is used to some extent in Ontario generating plants, with a CO_2 emission rate of 108.4 g/MJ.

67. Ontario Hydro, *Submission to*, Table 3.3, p. 3–27.

68. VHB Research & Consulting Inc., "Environmental Damage," Table 17, p. 55.

69. R. L. Ottinger, D. R. Wooley, N. A. Robinson, D. R. Hodas and S. E. Babb, *Environmental Costs of Electricity* (New York, NY: Oceana Publications, Inc., 1990).

70. Gillen and Levesque, *The Management*, see especially Tables 6-3 and 6-4, p. 188.

NOTES TO CHAPTER 8:
TRANSPORTATION SAFETY — ESTIMATION OF ACCIDENT RISKS AND COSTS

Introduction

The issues of transport safety were considered by the research staff of the Royal Commission, rather than through contracted research. The following notes are therefore more detailed than those supported by reports from contracted research.

1. Summary of Transport Safety

The history of transport safety shows that deaths, injuries and property damage have increased as traffic has grown. For example, there were 521 deaths in rail and road transport in 1921 and 4,060 deaths in 1990, while injuries and property damage increased faster still. The increase in accidents and casualties[1] over the long term, however, has been much less than the increase in traffic. The number of road fatalities grew quickly in the early days of motorization, but since 1930 it has only tripled, while the number of vehicles has increased 14-fold. It can be concluded that the "risks"[2] of accidents and casualties per vehicle-kilometre and per passenger-kilometre (pass-km) have fallen substantially. Recently, the improvement has been even more impressive. Since 1973, risks of death and serious injury have fallen faster than traffic has grown, so that the numbers of persons killed or seriously injured annually have fallen.

Within those transportation totals, it appears that risks have continued to decrease in passenger aviation and in trucking since deregulation. To the extent that deregulation has caused an increase in the use of smaller aircraft, some elevation of risks might be expected, but the reduction in risks from diverting traffic from road to air is likely to be much larger. In trucking, both the increase in truck traffic stimulated by deregulation and traffic diversion from rail are likely to increase truck accidents and the risks to other road users from trucks. There has been a strong downward trend in road accident risks, however, and improvements in vehicle and road technology, and in driver behaviour suggest that this will continue.

1.1 RELATIVE RISKS IN THE PASSENGER MODES

Table 8(2)-1 (which repeats Table 8-9 from Volume 1 of this report), provides two main safety indicators for comparisons among the passenger transportation modes. The first is the total numbers of persons killed in passenger operations — whether passengers, crew or bystanders — per billion pass-km. This indicator is referred to in Volume 1 as the "fatality rate in passenger operations." The importance of this indicator emerges when considering major changes in the extent of those operations, or major shifts among the modes, as it indicates how the total number of transportation-related deaths might change. The second indicator is the number of passengers killed per billion pass-km, referred to in Volume 1 as the "passenger fatality rate." This is the main indicator of the relative safety of passengers using the different modes, and is therefore of most interest to the travelling public.

Table 8(2)-1 illustrates these two fatality rates for the ground transportation modes and for three groups of air carriers. The following discussion describes those rates and considers possible trends for each mode.

Table 8(2)-1

FATALITY RATES[a] PER BILLION INTERCITY PASSENGER-KILOMETRE BY MODE

Mode	Passenger fatality rate[b]	Fatality rate in passenger operations[c]
Air — Level 1 carriers[d]	0.05	0.05
Air — Level 2 carriers[d]	0.7	1.0
Air — Level 3 to 6 carriers[d]	14.0	28.0
Train	0.8	13.8
Bus	0.0–1.0	2.0
Ferry	0.2	0.5
Car	10.0	13.0

a. Based on the 1980s as a whole, or recent years in 1980s.
b. Includes only passengers killed.
c. Includes passengers, crew and bystanders killed during passenger operations.
d. Includes all Canadian-registed carrier opeartions, domestic and international.

The many qualifications to these estimates follow. Important among them are that the traffic estimates are very rough for road transport, and that while all estimates are recent, they are not necessarily current. (The aviation and rail estimates are averaged over the last decade, for example, while the bus estimates are derived from accidents over a more limited period.) More importantly, the estimates are system-wide averages, and the trips — particularly their lengths — differ substantially by mode.

Within each mode, it is probable that risks are lower for longer trips. This is certainly the case for air travel, in which the risk falls with increasing stage length because of the dominance of the risks of landing and take-off, and because longer trips tend to be made in more reliable aircraft. It is probably also the case with rail travel, because longer trips are usually made over better-quality track (fewer grade crossings, in particular), and with bus travel, because the roads used are likely to be of better quality (divided highways, for example). For private motor-vehicle travel, better-quality roads will also be used on longer trips and, perhaps more importantly, the trips are more likely to be made in daylight, by experienced and unimpaired drivers using larger vehicles.

The qualifications on these estimates are particularly important in considering the effects of traffic shifting from one mode to another. For example, Table 8(2)-1 shows that shifting traffic from private motor vehicles to aircraft could save nearly one fatality for each 75 million pass-km, or that shifting 1% of highway car traffic to air-planes could prevent 27 deaths.[3] The true effects would probably be much less spectacular because the length of the trips that shifted would probably have a lower fatality rate than the road average, but would probably sustain a higher fatality rate than the air average.[4]

2. Summaries of Safety by Mode

Each of the modes is summarized here, focussing on passenger safety. Then, some aspects of heavy truck safety are considered, and finally a brief summary of developments in road safety is provided.

2.1 AVIATION SAFETY

Statistics on aviation accidents are available from the Transportation Safety Board, together with estimates of hours flown by type of operation. Statistics Canada provides estimates of pass-km for air carriers. The relevant figures and derived estimates of aviation risks for the years 1981 to 1990 are shown in Tables 8(2)-2 to 8(2)-8. Table 8(2)-3 shows that 1,176 people died in aviation accidents during the decade; approximately half in private-flying and half in commercial operations. Of 607 killed in commercial aviation, only 68 flew with Level 1 or 2 carriers; the remainder flew with smaller carriers.

Aviation accidents and fatalities are so rare that they vary substantially year to year, making estimation of accident rates per unit of traffic uncertain. Those rates may be calculated for each year per 100,000 flying hours, which is the industry measure common to all types of traffic. As shown in Tables 8(2)-4 and 8(2)-6, even the annual rate for total aviation fatalities fluctuates substantially, and annual rates for the separate types of traffic fluctuate more than this. For Level 1 and 2 carriers, the single accidents in 1983 and 1989 (Cincinnati and Dryden) changed the annual fatality rates dramatically. To compare these services with the other types of traffic, it is necessary to average the rates over the entire decade (or another long period). Table 8(2)-6 shows that between 1981 and 1990 the rate of fatalities per 100,000 hours for private aviation was more than double the rate for all commercial aviation. For Level 1 and 2 carriers combined, the fatality rate was only one fifth of that for other levels of carriers, and Level 1 carriers had about one twentieth of the fatality rate of Level 2 carriers.

Given that smaller aircraft have slower operating speeds, the disparity in the rates of fatalities per kilometre flown would appear even

greater between private and commercial services, and within the commercial services, between levels of carrier. Unfortunately, kilometres flown are not available for private aviation.

The comparisons rates of fatalities per pass-km among the various types of carrier, and how these rates change over time are of particular interest to the Royal Commission. Published data do not distinguish passengers from other fatalities (such as crew and others), so the major indicator that can be calculated is the "fatality rate in passenger operations." Tables 8(2)-7 and 8(2)-8 offer the relevant data. Again, to smooth the annual fluctuations, comparison is best made over the entire decade. Over the decade, Level 1 carriers provided about 95% of all pass-km by commercial carriers, with a fatality rate of 0.048 per billion pass-km, in other words, only one death every 20 billion pass-km. For Level 2 carriers, the rate was 1.0 fatality per billion pass-km (heavily influenced by the single Dryden crash), while for other levels of carriers the rate was as high as 28 deaths per billion pass-km, but their share was only 3.5% of all commercial pass-km.[5] For Levels 1 and 2 combined (the two national carriers, main feeders and charter operators), the fatality rate was 0.13 deaths per billion pass-km, one death every 7.7 billion pass-km.

Within those broader rates of fatalities in passenger operations, the passenger fatality rate can be distinguished using unpublished information provided by the Transportation Safety Board, which separates deaths of passengers from those of crew and others.[6] Figures obtained are aggregated over the decade 1981 to 1990, and show the following:

Class of carrier	Deaths of passengers	Deaths of others
Level 1	23	0
Level 2	34	11
Levels 3 to 6	270	269
All	327	280

Aviation Safety Indicators, 1981 to 1990

Table 8(2)-2
Aviation Operating Hours

Year	Hours of operation in year (thousands)						
	Level 1 carriers	Level 2 carriers	Other carriers	All com- mercial	Private	Govt.	Total
1981	661	147	1,853	2,662	1,332	126	4,119
1982	621	110	1,612	2,343	1,212	133	3,689
1983	588	111	1,474	2,173	1,150	124	3,447
1984	611	114	1,452	2,176	1,027	119	3,322
1985	660	154	1,390	2,204	934	118	3,256
1986	690	172	1,441	2,303	764	105	3,173
1987	705	182	1,533	2,421	800	100	3,321
1988	759	384	1,456	2,600	800	100	3,500
1989	677	405	1,618	2,700	800	100	3,600
1990	690	641	1,369	2,700	800	100	3,600
All	6,662	2,421	15,199	24,282	9,619	1,126	35,027

Sources: Canadian Aviation Safety Board and Transportation Safety Board.

Table 8(2)-3
Aviation Fatalities

Year	Number of fatalities in year						
	Level 1 carriers	Level 2 carriers	Other carriers	All com- mercial	Private	Govt.	Total
1981	0	6	79	85	85	2	172
1982	0	0	73	73	49	1	123
1983	23	4	41	68	78	2	148
1984	0	0	62	62	58	0	120
1985	0	0	42	42	29	0	71
1986	0	0	48	48	61	4	113
1987	0	0	44	44	52	1	97
1988	0	4	50	54	40	1	95
1989	0	31	53	84	64	2	150
1990	0	0	47	47	40	0	87
All	23	45	539	607	556	13	1,176

Sources: Canadian Aviation Safety Board and Transportation Safety Board.

Table 8(2)-4
Aviation Fatality Rates per 100,000 Operating Hours

Year	Fatality rates per 100,000 hours						
	Level 1 carriers	Level 2 carriers	Other carriers	All com-mercial	Private	Govt.	Total
1981	0.00	4.08	4.26	3.19	6.38	1.59	4.18
1982	0.00	0.00	4.53	3.12	4.04	0.75	3.33
1983	3.91	3.60	2.78	3.13	6.78	1.61	4.29
1984	0.00	0.00	4.27	2.85	5.65	0.00	3.61
1985	0.00	0.00	3.02	1.91	3.10	0.00	2.18
1986	0.00	0.00	3.33	2.08	7.98	3.80	3.56
1987	0.00	0.00	2.87	1.82	6.50	1.00	2.92
1988	0.00	1.04	3.43	2.08	5.00	1.00	2.71
1989	0.00	7.65	3.28	3.11	8.00	2.00	4.17
1990	0.00	0.00	3.43	1.74	5.00	0.00	2.42
All	0.35	1.86	3.55	2.50	5.78	1.15	3.36

Source: Calculated from data in Tables 8(2)-2 and 8(2)-3.

Table 8(2)-5
Aviation Fatal Accidents

Year	Number of fatal accidents in year						
	Level 1 carriers	Level 2 carriers	Other carriers	All com-mercial	Private	Govt.	Total
1981	0	1	39	40	47	1	88
1982	0	0	32	32	29	1	62
1983	1	1	17	19	43	1	63
1984	0	0	27	27	31	0	58
1985	0	0	18	18	22	0	40
1986	0	0	29	29	35	1	65
1987	0	0	23	23	29	1	53
1988	0	2	23	25	24	1	50
1989	0	3	21	24	34	1	59
1990	0	0	22	22	24	0	46
All	1	7	251	259	318	7	584

Source: Canadian Aviation Safety Board and Transportation Safety Board.

Table 8(2)-6
AVIATION FATAL ACCIDENT RATES PER 100,000 OPERATING HOURS

Year	Fatal accident rates per 100,000 hours						
	Level 1 carriers	Level 2 carriers	Other carriers	All com-mercial	Private	Govt.	Total
1981	0.000	0.679	2.104	1.503	3.529	0.794	2.136
1982	0.000	0.000	1.985	1.366	2.392	0.751	1.681
1983	0.170	0.900	1.153	0.874	3.739	0.806	1.828
1984	0.000	0.000	1.859	1.241	3.018	0.000	1.746
1985	0.000	0.000	1.295	0.817	2.355	0.000	1.228
1986	0.000	0.000	2.013	1.259	4.580	0.949	2.049
1987	0.000	0.000	1.500	0.950	3.625	1.000	1.596
1988	0.000	0.521	1.579	0.962	3.000	1.000	1.429
1989	0.000	0.741	1.298	0.889	4.250	1.000	1.639
1990	0.000	0.000	1.607	0.815	3.000	0.000	1.278
All	0.015	0.289	1.651	1.067	3.306	0.622	1.667

Source: Calculated from data in Tables 8(2)-2 and 8(2)-5.

Table 8(2)-7
AVIATION PASSENGER-KILOMETRES

Year	Pass-km in year (millions)						
	Level 1 carriers	Level 2 carriers	Other carriers	All com-mercial	Private	Govt.	Total
1981	45,300	395	383	46,078	not	not	not
1982	42,855	597	750	44,202	available	available	applicable
1983	41,895	737	783	43,415			
1984	44,690	1,262	904	46,856			
1985	47,181	1,819	967	49,967			
1986	47,788	2,779	2,517	53,084			
1987	48,266	4,787	2,311	55,364			
1988	54,121	7,491	2,248	63,860			
1989	53,049	10,115	4,961	68,125			
1990	50,125	15,883	3,393	69,401			
All	475,270	45,865	19,217	540,352			

Sources: For unit toll services: Statistics Canada, *Aviation in Canada*, Catalogue No. 51-501, Dec. 1986, and *Canadian Civil Aviation*, Catalogue No. 51-206. For charter services: private communication from Statistics Canada, Aviation Statistics Centre.

Table 8(2)-8
AVIATION FATALITY RATES PER BILLION PASSENGER-KILOMETRES

Year	Level 1 carriers	Level 2 carriers	Other carriers	All com-mercial	Private	Govt.	Total
1981	0.000	15.190	206.266	1.845	not available	not available	not applicable
1982	0.000	0.000	97.333	1.652			
1983	0.549	5.427	52.363	1.566			
1984	0.000	0.000	68.584	1.323			
1985	0.000	0.000	43.433	0.841			
1986	0.000	0.000	19.070	0.904			
1987	0.000	0.000	19.039	0.795			
1988	0.000	0.534	22.242	0.846			
1989	0.000	3.065	10.683	1.233			
1990	0.000	0.000	13.852	0.677			
All	0.048	0.981	28.048	1.123			

Source: Calculated from data in Tables 8(2)-3 and 8(2)-7.

Dividing these figures by the pass-km travelled by carriers of each level (given in Table 8(2)-7) results in passenger fatality rates per billion pass-km as follows:

Class of carrier	Fatalities per billion pass-km
Level 1	0.048
Level 2	0.741
Levels 3 to 6	14.050
All levels	0.605

While these rates represent the decade's experience, it must be emphasized that the rates for Level 1 and 2 carriers are the result of an extremely small number of crashes, and may change radically in a short period due to the large numbers of passengers potentially involved in single events. At the time of writing, it is known that a single crash of a Level 2 carrier's aircraft in 1991 has changed the 10-year average radically.[7] This event has not been included in

the intermodal comparisons in the Royal Commission's report, in consequence of a decision to standardize information by using the most recent decade (1981 to 1990) for which data are currently available in most of the modes.

2.1.1 How is Passenger Aviation Safety Changing over Time?

From the information in Tables 8(2)-2 to 8(2)-8, it appears that the fatal accident rates and fatality rates per pass-km for all commercial operations have improved over the decade. Examining the rates by level of carrier, however, shows that the trend was determined essentially by the experience of the smaller carriers. The infrequency of crashes among Level 1 and 2 carriers makes it impossible to determine whether their safety has improved over the period, or to make a confident estimate of the expected fatality rates for those carriers in the immediate future.

For greater confidence, we can look to safety experience in the United States, which has similar aircraft and operating conditions, but much larger numbers of operations and pass-km. We have no reason to believe Canadian carriers have worse safety records than their U.S. counterparts (and some evidence that Canadian safety records are better). In the United States, we can see a 30-year trend of reductions in accidents and fatalities per billion pass-km.[8]

2.1.2 What Has Been the Effect of Airline Deregulation on Safety?

The effect of Canadian deregulation in stimulating Level 1 and 2 carriers' traffic can be seen in Tables 8(2)-2 and 8(2)-7. No effect on aviation fatalities can be discerned, because of the uncertainty in estimating fatality rates in the short term. The hypothesis that deregulation would reduce profitability and lead to cuts in safety was tested to some extent in a recent Canadian study.[9] While the study found some intriguing evidence that spending by carriers on maintenance is associated with lower rates of accidents (broadly defined), it found no relationship between the profitability of carriers and their overall accident experience.

We can turn again to the United States, which has much larger numbers of flights and pass-km, for evidence of the safety effect of deregulation. Several experts have concluded that U.S. deregulation has not led to a degradation of safety.[10] Since deregulation in 1978, accident rates have followed the downward trend established in the regulated period. Moore shows that, during the period 1979 to 1986, total air carrier accidents, fatal accidents and fatalities all declined by over 40% compared with the period 1971 to 1978, and the rates per flight hour declined even more.[11] Oster and Zorn compare the period 1979 to 1985 with 1970 to 1978, and conclude that for all U.S. domestic scheduled services, fatal accidents per million aircraft departures more than halved from 0.46 to 0.22, while passenger fatalities per million passenger enplanements fell from 0.42 to 0.30.[12]

There had been concern that deregulation would switch traffic from major carriers to commuter carriers, and that the latter had worse safety records. Comparing the same periods, however, showed only slightly greater growth in flight hours for air taxis and commuter airlines than for scheduled large jet air carriers (29.8% versus 26.1%).[13] More importantly, passenger safety was shown to improve more for smaller carriers than for larger carriers. Oster and Zorn show that on domestic scheduled services, fatalities per million passengers remained essentially unchanged among trunk carriers, and also among the 20 largest commuter carriers, but fell by over 60% among the smaller commuter carriers.[14] They explain that much of the reduction resulted from a change in average stage length among the commuter carriers. The records of commuter carriers per pass-km reflect their shorter average stage lengths, and the fact that rates of accidents and deaths fall with increased stage length because the risks are much lower when cruising compared with landing or taking off. (This also partially explains the apparently higher fatality rates of Canadian Level 2 carriers compared with Level 1, and of Levels 3–6 carriers compared with Level 2.) The switch to commuter lines following deregulation was part of the hub-and-spoke development, which actually reduced the number of stops on a typical passenger's flight, thereby substantially improving the commuter carriers' safety.[15]

Overall, researchers reach the cautious conclusion that, although the increase in commuter traffic possibly raised average risks per pass-km compared with what might have occurred without deregulation, air safety continued to improve.

Furthermore, commentators note that, to the extent that aviation deregulation diverted traffic from road to air travel, the safety of that traffic improved substantially (see notes on road passenger risks). A study by Bylow and Savage uses a model of highway travel demand to estimate the reduction in road travel as a result of airline deregulation, and then uses U.S. rural highway fatality rates per vehicle-kilometre to estimate the reduction in highway deaths. The authors suggest that highway deaths were reduced by 3,000 over the period 1978 to 1988, dwarfing estimates of the effects of deregulation in raising the risk of air fatalities.[16]

2.2 RAIL SAFETY

Major indicators of rail safety are provided in Tables 8(2)-9 to 8(2)-12. Table 8(2)-9 first shows deaths arising from all rail operations, most of which transport freight, of course. Over the decade to 1990, there was a total of 1,255 deaths. Half occurred in grade crossing accidents, and nearly all were occupants of the motor vehicles struck. Another 40% were persons struck by trains, either employees, or persons walking on tracks, including suicides. Only 54 deaths (less than 5% of the total) came from collisions or derailments, and 24 of these occurred in a single crash in 1986 at Hinton, Alberta.

The annual total of fatalities declined fairly steadily through the decade. Table 8(2)-10 shows that train-kilometres also declined, but less than fatalities, so the overall fatality rate per train-kilometre declined slightly over the period. Among the accident types, deaths in collisions and derailments are so rare that annual rates per train-kilometre are too unstable to show trends. Little change over time can be discerned in the death rate of persons struck by trains, but some improvement does seem to have occurred in the rate of deaths from grade crossing accidents.

Table 8(2)-9
FATALITIES IN RAIL ACCIDENTS, 1981 TO 1990

| Year | Fatalities by type of incident | | | | | |
	Main-track collisions/ derailments	Other collisions/ derailments	Grade crossing accidents	Persons struck on track	Other	Total
1981	3	2	82	62	4	153
1982	0	4	77	57	7	145
1983	6	2	60	52	6	126
1984	1	0	70	51	2	124
1985	0	4	58	61	5	128
1986	24	0	47	44	3	118
1987	0	1	50	53	2	106
1988	2	0	58	49	2	111
1989	0	5	85	49	2	141
1990	0	0	47	53	3	103
All	36	18	634	531	36	1,255

Source: Transportation Safety Board.

Table 8(2)-10
FATALITY RATES IN RAIL ACCIDENTS, 1981 TO 1990

| Year | Train-km (m) | Fatalities per million train-km by type of incident | | | | | |
		Main-track collisions/ derail-ments	Other collisions/ derail-ments	Grade crossing accidents	Persons struck on track	Other	Total
1981	131.9	0.023	0.015	0.622	0.470	0.030	1.160
1982	113.3	0.000	0.035	0.680	0.503	0.062	1.280
1983	116.8	0.051	0.017	0.514	0.445	0.051	1.079
1984	124.5	0.008	0.000	0.562	0.410	0.016	0.996
1985	121.3	0.000	0.033	0.478	0.503	0.041	1.055
1986	120.8	0.199	0.000	0.389	0.364	0.025	0.977
1987	122.8	0.000	0.008	0.407	0.432	0.016	0.863
1988	125.7	0.016	0.000	0.462	0.390	0.016	0.883
1989	119.9	0.000	0.042	0.709	0.409	0.017	1.176
1990	112.8	0.000	0.000	0.417	0.470	0.027	0.913
All	1,209.8	0.030	0.015	0.524	0.439	0.030	1.037

Sources: Train-kilometres from Transportation Safety Board; fatality rates computed by Royal Commission staff from train-kilometres plus data in Table 8(2)-9.

Table 8(2)-11
FATALITIES IN RAIL PASSENGER OPERATIONS, 1981 TO 1990

Year	Fatalities by type of victim				
	Passengers	Crew	Victims at crossings	Trespassers	Total
1981	0	0	17	14	31
1982	0	0	17	14	31
1983	4	1	10	17	32
1984	0	0	21	9	30
1985	0	0	21	16	37
1986	16	7	18	16	57
1987	0	0	12	11	23
1988	0	0	12	7	19
1989	0	0	27	15	42
1990	0	0	19	14	33
All	20	8	174	133	335

Source: Personal communication between Transportation Safety Board staff and Royal Commission staff.

Table 8(2)-12
FATALITY RATES IN RAIL PASSENGER OPERATIONS, 1981 TO 1990

Year	Intercity pass-km (millions)	Fatality rates per billion intercity pass-km				
		Passengers	Crew	Victims at crossings	Trespassers	Total
1981	2,844	0.000	0.000	5.977	4.923	10.900
1982	2,267	0.000	0.000	7.499	6.176	13.674
1983	2,545	1.572	0.393	3.929	6.680	12.574
1984	2,515	0.000	0.000	8.350	3.579	11.928
1985	2,622	0.000	0.000	8.009	6.102	14.111
1986	2,390	6.695	2.929	7.531	6.695	23.849
1987	2,236	0.000	0.000	5.367	4.919	10.286
1988	2,418	0.000	0.000	4.963	2.895	7.858
1989	2,798	0.000	0.000	9.650	5.361	15.011
1990	1,473	0.000	0.000	12.895	9.501	22.396
All	24,108	0.830	0.332	7.217	5.517	13.896

Sources: Intercity pass-km from Statistics Canada, *Railway Transport: Part IV, Operating and Traffic Statistics*, Catalogue No. 52-210, to 1981, and unpublished data thereafter, with interpolation for 1990 from VIA Rail annual report; fatality rates calculated by Royal Commission staff from pass-km plus data from Table 8(2)-11.

The safety of passenger rail operations is portrayed in Tables 8(2)-11 and 8(2)-12 (provided by the Transportation Safety Board from unpublished tabulations). Passenger fatalities averaged about two per year, but there were no deaths in eight of the years, and 16 deaths in 1986 in the single crash at Hinton. Over the decade, passenger operations also resulted in eight crew deaths, 174 deaths at grade crossings, and the deaths of 133 trespassers.

Table 8(2)-12 shows that pass-km on intercity rail services fluctuated somewhat during much of the decade, but then dropped by nearly half in 1990, following the major cuts in VIA Rail services. The same Statistics Canada source shows that commuter pass-km rose over the period, comprising 13% of total pass-km in 1981, and 19% in 1988. The fatality rates in Table 8(2)-12 (and in Chapter 8 of Volume 1 of this report) are expressed relative to pass-km for intercity services, while the fatality estimates in Table 8(2)-11 include deaths occurring in commuter services. The fatality rates are therefore somewhat overstated. Table 8(2)-12 first shows the passenger fatality rate for the decade, averaging 0.83 deaths per billion intercity pass-km. It then shows fatality rates for each of the types of non-passenger, and finally totals the overall fatality rate in passenger operations, which averaged 13.9 over the period. It can be seen that the annual passenger fatality rate per pass-km is subject to major, erratic variation because of variability in the frequency of deaths, and therefore no trend can be recognized. The annual total fatality rate in passenger operations is less variable, but shows no trend over this relatively short period.

2.3 INTERCITY BUS SAFETY

Statistics describing the safety of intercity bus operations are very sparse. Provinces and territories are responsible for their own road accident reporting systems, and none routinely reports the total numbers of casualties cross-referenced to the types of vehicles involved in the accidents. Only five jurisdictions (Saskatchewan, Manitoba, Ontario, Nova Scotia and Newfoundland) have distinguished intercity buses from transit buses in their police report forms and computer

systems. All jurisdictions recently agreed to report annually to the Canadian Council of Motor Transport Administrators the number of victims killed and injured in intercity buses as part of the effort to monitor the impact of deregulation and the National Safety Code. Their agreement, however, has not been implemented.

Table 8(2)-13 presents a special tabulation from Transport Canada's provincial and territorial computer files showing victims killed and injured in accidents involving intercity buses in the five provinces listed.[17] The table combines the numbers for the three years from 1985 to 1987, showing a total of seven deaths and 265 injuries in these accidents. Of these, no bus occupants were killed, and 27 bus drivers and 73 bus passengers were injured. All seven deaths, and 135 of the other 165 injured, were occupants of other vehicles, which were nearly all cars or light trucks. Only four of the bus occupants and 17 of the other victims were injured severely enough to require hospitalization.

Table 8(2)-13
INTERCITY BUS ACCIDENT VICTIMS, FIVE PROVINCES,[a] 1985 TO 1987

Victim type	Severity of Injury[b]			
	Minimal	Minor	Major	Fatal
Bus driver	16	10	1	0
Bus passenger	51	19	3	0
Occupant of other vehicle	74	47	14	7
Motorcyclist	2	3	0	0
Bicyclist	2	5	0	0
Pedestrian	5	10	3	0
All	150	94	21	7

Source: Personal communication between staff of Transport Canada and Royal Commission staff.

a. Saskatchewan, Manitoba, Ontario, Nova Scotia and Newfoundland.

b. Minimal — no treatment required;
Minor — treated but not admitted to hospital;
Major — admitted to hospital.

This tabulation can offer no indication of trends over time, and suggests that the annual numbers would be too small to allow trends to be recognized easily even if a long series were available. It is possible only to speculate about trends, but it is relevant that the majority of victims in these accidents were in cars and light trucks, and it is known that the accident rates and "crashworthiness" of those vehicles (the ability of occupants to survive crashes) have improved over time. Improvement will likely continue as accident avoidance capabilities are developed (for example, through anti-lock braking systems, hazard detection systems, and the vehicle guidance aspects of "intelligent vehicle-highway systems"), crashworthiness is improved (through air bags and enhanced side-impact protection) and seat belts are used more consistently.

No estimates of the death and injury rates per intercity bus vehicle-kilometre and pass-km can be made confidently from the information available, particularly as we have no estimates of pass-km travelled in the five provinces concerned. Making the very heroic assumption that the ratio of intercity bus casualties to total road casualties in these five provinces is the same in other jurisdictions, it is possible to estimate total casualties in intercity bus accidents for the three years from 1985 to 1987 as approximately 17 fatalities and 500 injured. Total national traffic in intercity bus services in 1991 is estimated by Royal Commission staff as 3.3 billion pass-km. If traffic was at that same level during 1985 to 1987, the total for the three years would have been 9.9 billion pass-km, and the average risk of fatalities in passenger operations for the period would therefore have been 1.7 deaths per billion pass-km. Due to the uncertainty in both the number of deaths and the traffic estimates, this fatality rate is rounded in Chapter 8 of Volume 1 of this report as 2.0 deaths per billion pass-km.

From the information available, none of the victims during these three years was a bus occupant, so the estimated bus passenger fatality risk would be zero — clearly incorrect as a representation of the long-term risk. To provide some indication of the likely risk, in

order to make intermodal comparisons in Volume 1 of this report, it is guessed that passenger fatalities constitute less than half the total fatalities in bus operations. Noting that passengers constituted 73 of the total of 265 injured victims, the true bus passenger risk would lie somewhere between 0 and 1.0 deaths per billion pass-km.

2.4 FERRY SAFETY

Statistics from the Transportation Safety Board (unpublished tabulation) on passenger deaths on ferries are summarized in Table 8(2)-14. These relate to all ferries in Canada, not just the longer services on which the Royal Commission has focussed in Volume 1.[18] The table distinguishes the latter "intercity" ferries from those relating to "river or harbour crossings," showing that six passengers died on intercity ferries during the decade to 1990, of a total of 20 passenger deaths on all ferries.

Table 8(2)-14
PASSENGER DEATHS IN ACCIDENTS ABOARD FERRIES

Year	Intercity ferries	River/harbour crossings	Total
1981	1	3	4
1982	1	3	4
1983	0	1	1
1984	0	3	3
1985	1	1	2
1986	2	0	2
1987	0	0	0
1988	1	0	1
1989	0	0	0
1990	0	3	3
All	6	14	20

Source: **Personal communication between Transportation Safety Board staff and Royal Commission staff.**

Fatalities in ferry passenger operations should also include deaths of crew and any other non-passengers. Other unpublished statistics from the Transportation Safety Board show that there were a total of 26 deaths aboard or involving ferries during the decade.[19] From this

it can be deduced that six of those who died were not passengers. The proportion of those non-passenger deaths occurring in the intercity services is not known, but, if similar to the proportion among passenger fatalities, would mean that two of the six were in intercity services. The total number of deaths in intercity passenger ferry operations during the decade is therefore estimated at eight.

To assess risks associated with ferry transport, these rough estimates of fatalities are converted to annual averages. Passenger fatalities amounted to about 0.6 per year during the decade, and total fatalities in passenger operations to about 0.8 per year. Passenger-kilometres are not available in traffic records for the whole decade, but have been estimated, in the Notes to Chapter 3 of this report, for all the intercity ferries, at about 830 million pass-km in 1990. Assuming that the average annual fatalities for the decade were constant,[20] estimated risks for passenger deaths are 0.7 deaths per billion pass-km, and for fatalities in passenger operations about 1.0 deaths per billion pass-km.

2.5 PRIVATE MOTOR-VEHICLE SAFETY IN INTERCITY TRAVEL

The aggregate risks associated with intercity passenger travel by private motor vehicles (cars, vans and light trucks) can be roughly estimated as follows. Transport Canada statistics of motor-vehicle traffic accidents provide the number of fatalities on roads with speed limits greater than 60 km/h — including highways and local rural roads. In 1989 there were 2,808 such fatalities, constituting 65% of total motor vehicle fatalities for the year.[21] The Royal Commission's estimate of total highway passenger-vehicle traffic for the year was 210 billion pass-km. Comparing the two gives a fatality rate of 13 per billion pass-km, or one fatality for every 80 million pass-km. In addition, we can estimate the rate of persons injured (of all severities) as 440 per billion pass-km.

The passenger fatality rate in road use is interpreted differently than in the public transport modes because there is no important distinction between private vehicle passengers and "crew." Private vehicle

operators are nearly always travellers themselves (professional drivers being rare exceptions), and so should be included in the calculation of a passenger fatality rate. This rate differs considerably from the fatality rate in passenger operations, because private-vehicle occupants (drivers and other occupants) constitute about 80% of the total fatalities. The remainder are pedestrians, motorcyclists, bicyclists or occupants of vehicles of other types (heavy trucks, mobile equipment, and so on). In 1989 the passenger fatality rate was about 10 per billion pass-km.

2.6 HEAVY TRUCK SAFETY

As in the intercity bus case, information on truck safety has not been routinely available due to the failure of the provinces and territories to tabulate their records of accident victims by vehicle type. Limited information has become available recently as a result of the agreement through the Canadian Council of Motor Transport Administrators to monitor the effects of the National Safety Code. (This information provides the input to Transport Canada's annual report to Parliament on "Commercial Vehicle Safety in Canada," required under the *National Transportation Act, 1987*.) The information is limited particularly because it provides no details on the number of accident victims. Instead, it merely indicates the number of accidents of each severity in which heavy trucks were involved. These numbers are provided for the years 1986 to 1988 in Table 8(2)-15.

Traffic data comparable with the accident information in Table 8(2)-15 are not available. National compilations of the numbers of vehicles registered do not even distinguish heavy trucks from light trucks (that is, pickups and small vans, which probably outnumber heavy trucks by 10 times). No vehicle-kilometre information exists beyond that obtained for part of the heavy truck fleet from Statistics Canada's surveys of major carriers and partial surveys of private trucking. For some provinces, it is possible to estimate that heavy trucks account for about 3% of vehicles registered. By extrapolation, one can roughly estimate that they account for 9% of total vehicle-kilometres by

road.[22] In contrast, the table shows that trucks were involved in slightly less than 3% of non-fatal injury accidents in each of the three years, but in about 9% of all fatal accidents. It seems likely that trucks are substantially under-involved in accidents relative to their vehicle-kilometres travelled — that is, they are less likely to crash per vehicle-kilometre than cars — but when accidents occur the greater weight of the trucks makes the consequences more severe.[23]

Table 8(2)-15
HEAVY TRUCK INVOLVEMENTS IN ACCIDENTS, 1986 TO 1988

Fatal accidents						
	Year 1986		Year 1987		Year 1988	
Vehicle type	Number	%	Number	%	Number	%
Straight truck	141	2.6	190	3.3	195	3.5
Tractor-trailer	319	5.8	344	5.9	327	5.8
Pickup/van	918	16.7	940	16.2	988	17.6
Automobile	3,200	58.3	3,581	61.6	3,497	62.2
Other	913	16.6	760	13.1	616	11.0
Total	5,491	100.0	5,815	100.0	5,623	100.0
Injury accidents						
	Year 1986		Year 1987		Year 1988	
Vehicle type	Number	%	Number	%	Number	%
Straight truck	4,848	1.5	4,886	1.4	5,461	1.6
Tractor-trailer	3,986	1.2	4,289	1.3	4,151	1.2
Pickup/van	38,780	12.0	42,044	12.3	43,624	13.0
Automobile	235,819	73.1	255,312	74.7	251,018	75.0
Other	39,163	12.1	35,473	10.4	30,597	9.1
Total	322,596	100.0	342,004	100.0	334,851	100.0

Source: Personal communication between staff of Transport Canada and Royal Commission staff.

Just how severe is shown in Table 8(2)-16, which compares injuries sustained by the truck occupants with those of the other victims in these accidents. From a large sample of heavy truck accidents analyzed by Transport Canada staff,[24] the table shows that a total of 90 truck occupants were killed and 4,078 injured. About half of these were single-vehicle accidents. Non-truck victims accounted

for 392 deaths and 6,806 injuries. Sixty-seven of those killed were pedestrians, bicyclists or motorcyclists — the most vulnerable road users — and the other 324 were occupants of cars or light trucks. Accidents involving cars or light trucks illustrate the disproportion in risks faced by the light and heavy vehicle occupants: the accidents produced 27 times as many deaths in light vehicles as in heavy trucks (324:12), and 4.6 times as many injuries.

Table 8(2)-16
HEAVY TRUCK OCCUPANT CASUALTIES (SAMPLE 1984 TO 1986)

Traffic unit	Victims in truck		Victims not in truck	
	Killed	Injured	Killed	Injured
Pedestrian	0	0	40	188
Bicycle	0	0	11	79
Motorcycle	0	2	17	128
Car/light truck	12	1,380	324	6,411
Straight truck	10	349	—	—
Tractor-trailer	15	561	—	—
No other unit	53	1,786	—	—
Total	**90**	**4,078**	**392**	**6,806**

Source: E.R. Welbourne and P. Gutoskie, "Heavy truck accidents, casualties and counter-measures," *Proceedings of the Canadian Multidisciplinary Road Safety Conference VI* (Fredericton, N.B.: University of New Brunswick, 1989) pp. 183–93.

2.6.1 Effects of Increasing Truck Sizes

Canada allows substantially larger and heavier trucks to use its highways routinely than does the United States, particularly since the signing of a Memorandum of Understanding among provinces and territories in September 1989.[25] This agreement followed extensive review of the issue of the safety of various trucks, and original work (by the National Research Council, through TAC) on the stability of heavy truck configurations. Evidence on the safety of different classes of truck from over-the-road experience is confounded by differences in operating conditions. Studies find lower accident involvement rates for combination trucks (various tractor and trailer configurations) than for the lighter and shorter straight trucks, and lower rates for double-trailer combinations than for single trailers.[26] It is clear that

the larger, heavier trucks operate in more favourable conditions, in particular on major rural highways that have lower accident rates for all traffic, and probably operate with more experienced and capable drivers. Comparing trucks under similar conditions, the U.S. Transportation Research Board finds that the accident and fatality rates of trucks increase with gross weight and dimensions, but by much less than the carrying capacity.[27] This suggests that transferring loads to larger trucks, and therefore using fewer trucks for a given tonnage of freight, improves safety per tonne-kilometre.

2.6.2 Effects on Safety of Trucking Deregulation

Table 8(2)-15 can also be examined for evidence of trends in the three years, the latter two of which followed deregulation of trucking. The numbers concerned are small, but do seem to indicate that the accident involvement of heavy trucks increased after 1986, relative to all other vehicles. This is more pronounced for fatal accidents than non-fatal, and appears confined to "straight trucks" rather than tractor-trailer combinations. No traffic information is available, however, to explain whether this represents an increase in the fatal accident rate per vehicle-kilometre, an increase in vehicle-kilometres, or any change in operating conditions.

Evidence from the United States, which has many more trucks and accidents, allows more precise assessments. The conclusions of a seminar held in 1987 were that truck safety has continued to improve during the period since deregulation (a reduction from 64 fatal accidents per billion vehicle-kilometres in 1978, to an average of 54 between 1983 and 1985).[28] The U.S. Department of Transportation concluded more recently that, from 1977 to 1988, the rate of fatal crash involvements for single-unit trucks fell by one third, and the rate for combination trucks by 40%, while the rate for passenger vehicles declined by 25%.[29]

2.7 OVERALL TRENDS IN ROAD SAFETY[30]

The trends in road traffic and safety from 1950 to 1990 are illustrated in Chart 8(2)-1 by two main indicators: the size of the motor vehicle fleet and the number of road accident fatalities. (Consistent estimates

of vehicle-kilometres are not available.) Road traffic has grown almost without interruption since the invention of the motor vehicle. Since 1950, the vehicle fleet has become six times as large. The chart shows that deaths have increased with traffic, but not consistently. The number of deaths grew until 1973, and fell since then, but with substantial perturbations in the trend. Fatalities approximately trebled between 1950 and 1973, from 2,272 to 6,706. During this 24-year period, a total of 98,196 people died in road accidents.

Extrapolation of the simple trend observed prior to the year 1973 suggested that a further 230,000 would die in road accidents between then and the end of the century; and that over 130,000 would die between 1973 and 1990. In fact, the trend in fatalities changed quite abruptly after 1973. Since then, the annual toll has fallen almost every year. In 1990, it was 3,957, which was 40% lower than in 1973,

Chart 8(2)-1
TRENDS IN ROAD TRAFFIC AND SAFETY, 1950 TO 1990

Number of fatalities ('000s)   Number of vehicles registered (millions)

Year

Fatalities   Vehicles registered
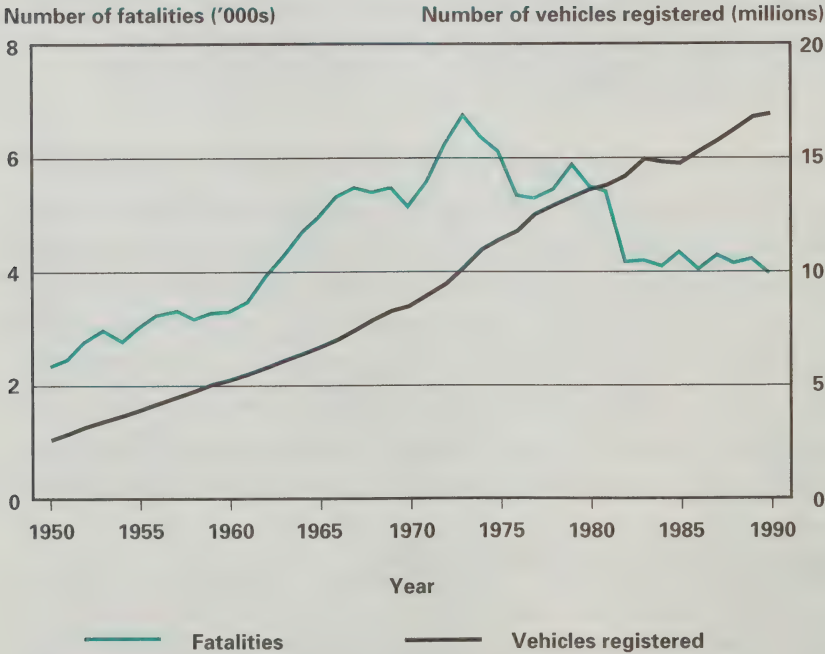
and lower than in any year since 1962. For the period 1974 to 1990, the total deaths were 82,619, but this was one third lower than was predicted from the trend prior to 1973.

The trend to 1973 was of a long-term decline in the average rate of fatalities per vehicle as the vehicle fleet grew. There were, however, substantial fluctuations in that trend, including some sustained periods, such as 1961 to 1966 and 1970 to 1973, when fatalities grew faster than the vehicle fleet and faster than total traffic. Such periods can be shown (in other developed countries as well as Canada) to coincide with spurts in economic growth.[31]

Since 1973, the decline in the average fatality rate has been much sharper, and rose only in 1979 and 1985. While the rate of deaths per 10,000 vehicles fell from 8.7 to 6.6 in the 23 years between 1950 and 1973, it then fell by more than two thirds to 2.3 in the next 17 years to 1990. The sharpest reductions in the fatality rate occurred in 1974 and 1982, which were years of depressed economic activity. But strong economic growth between those years brought no more than a slight increase in deaths in 1979, and sustained growth from 1982 to 1989 produced no increase. It seems safe to conclude that a fundamental improvement in safety — a change in the underlying relationship of fatalities to traffic — has occurred since 1973.

Chart 8(2)-2 supports this conclusion with simple comparisons of trends in Canada with those in other developed countries. The chart shows fatalities represented by indices, with 1973 levels set to 100, for Canada, the United States, and a combined group of 19 countries of the European Conference of Ministers of Transport (ECMT). It is clear that there has been a much greater proportional reduction in fatalities in Canada than in these other countries since 1973, particularly since 1981.

Chart 8(2)-2
INDEX OF FATALITIES, 1973=100

Deaths as a percentage of 1973 value
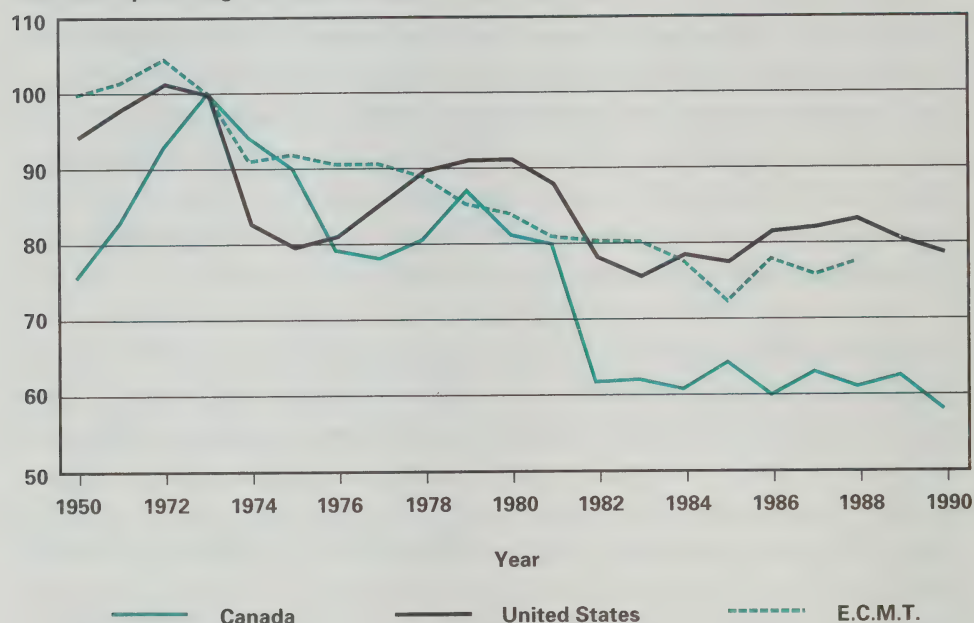
Some major aspects of these improvements are summarized below.

(i) Deaths by type of road user: Driver fatalities have remained almost constant over the past couple of decades, and now amount to about 1,900 annually; while those of passengers have fallen to about 1,100 per year reflecting reductions in vehicle occupancies with increased motorization. Pedestrian deaths have shown the largest reduction, and there are less than half as many deaths (600) as 20 years ago. Motorcyclist deaths increased until about 1983, but have since declined by 40% to about 250 per year; and bicyclist deaths have remained relatively constant, at about 100 deaths a year.

(ii) Deaths by age-group: Assessing the period from 1957 to 1987 shows:

• Age-group 0 to 4 contributes only about 2% of deaths; the fatality rate per capita is less than one third of the average for all groups

and has fallen faster than the average; the population of the group fell by 9%.

- Age-group 5 to 14 contributes about 6% of all deaths; the fatality rate per capita is less than half the average; population of the group declined 21% in the period.

- Age-group 15 to 24 contributes nearly 30% of all deaths — a remarkable over-representation; the fatality risk per capita is two and a half times that of the average of the other age-groups, but has recently fallen faster than the average; the population is larger than in 1970, but has contracted since 1980.

- Age-group 25 to 64 contributes 50% of all deaths; the fatality rate per capita fell overall by 40% over 20 years; the population grew by about 50%.

- Age-group 65 and over contributes nearly 15% of total deaths; the rate of fatalities per capita is slightly higher than the average for all age-groups and is falling faster than the average over the period; but growth in the population of the age-group is stronger than the reduction in its fatality rate per capita, so the absolute number of deaths in the group is rising.

2.7.1 Effects of Safety Measures

These trends show that the decline of fatalities in Canada can be explained partially through demographic changes, but mostly remains unexplained. The information available on the effectiveness of programs in road improvement, vehicle performance regulation, or road user education and control, however, is surprisingly poor. The complex relationships among contributing factors, and the poverty of data describing them, have meant that efforts at modelling and explaining the processes have not been very successful. Gaudry's modelling of relationships between social factors and accidents in Quebec is unusual in allowing recognition of the influences of a number of the factors with some statistical confidence.[32] But the introduction of safety measures is rarely immediate enough or sufficiently widespread so that the effects could be assessed accurately even with such a model.

Furthermore, an intriguing aspect of the overall trends is that, in one way, they appear simple to describe: that is, in the long-term decline in the fatality rate per vehicle (or vehicle-kilometre). Researchers have shown in a number of countries that a simple curve describes how the fatality rate declines as the level of motorization (vehicles per capita) grows.[33] They further suggest that the relationships are very similar in many countries — in other words, that different countries have very similar fatalities per vehicle at the same level of motorization. Although this generalization is attractive, it would worry safety programmers because it suggests that safety programs are a waste of time and that improvement over time is inexorable with increasing motorization.

The notion of such a simple determination of the fatality rate is countered by evidence that there are important changes in the relationship over time in any country, and among countries.[34] A substantially different interpretation of the change in the fatality rate over time has recently emerged, particularly from researchers at the Institute for Road Safety Research in The Netherlands.[35] They suggest that the trend in the fatality rate can best be described by a very simple relationship derived from mathematical "learning theory." This they interpret to mean that the phenomenon of a declining fatality rate results from "social learning" about safety — a growing understanding by all involved of the means of controlling motorization. The part played by all the various safety programs still remains conjectural — these researchers suggest that the progressive implementation of safety measures has been part of social learning, but have no specific evidence for their effects.

Such evidence should have accumulated from evaluations of specific safety measures using laboratory experiments, or careful observations of the effects of measures that have been implemented. Unfortunately, it has proven difficult to predict from laboratory experiments how safety measures will be received when implemented (for example, how drivers will react to changes in road markings, or to improvements in vehicle performance). In particular, it has been found that

road users adapt their behaviour to changes in equipment or controls, and often in a way that reduces the intended safety gain.[36] One hypothesis has held that adaptation is intended to keep risks constant,[37] while other empirical evidence shows that the extent of adaptation is unpredictable.[38]

To identify the effects specific to a safety measure, evaluations of its implementation attempt to control for changes in traffic and other extraneous factors. Unfortunately, most evaluations are controlled poorly, and many evaluations are subject to upward biases in their estimates of safety improvements,[39] so all claims for the effects of preventative measures should be viewed with great suspicion.

In sum, there are not many measures that safety researchers would agree have been demonstrated to be effective. The list would probably include:

- a number of major highway improvements (generally for capacity expansion purposes), including grade separation, straight and flat alignments, and paved shoulders;

- guardrails, crash barriers and edge-linings;

- minor improvements on roads at "black spots," for example, to sight-lines, surface conditions, traffic signs and controls;[40]

- a number of U.S. and Canadian motor vehicle performance standards, particularly those for crashworthiness, including standards for deflecting steering columns, side door beams, windshields, door locks, seat belts and air bags;[41]

- seat-belt use laws and their enforcement;[42] and

- random breath testing to enforce laws against drunk-driving.[43]

The list would probably not include some very popular remedies, such as motor vehicle inspection,[44] high-school driver education,[45] and most public information campaigns.[46]

2.7.2 Possible Future Trends

Some of the trends noted earlier can be expected to continue. One of the major changes noted was the disproportionate reduction in pedestrian and passenger fatalities. The reduction in pedestrian fatalities should slow because the changes were proportionately so large, and because underlying contributors, such as the decline in the child population and school consolidation, have slowed. Passenger fatalities could continue to drop relative to driver fatalities if the vehicle fleet continues to grow faster than the population, because vehicle occupancies could be expected to continue to fall.

The effects of future demographic trends must also be factored into the predictions. The contraction of the youngest age-group appears to have ceased, and the child population can be expected to be more stable in the immediate future. The group 25 to 64, with an aggregate fatality rate that is close to the average, will continue to provide the bulk of total population growth. The oldest age-group, over 64, will also continue to grow fastest, exerting an upward pressure on average fatality rates. For the next decade or so, this will be more than offset by the continuing contraction in the young adult group aged 15 to 24, with its very disproportionate risks.

Overall, none of these effects seems likely to be very dominant in changing the fatality rate from its current level. The main determinant of the change in fatalities will continue to be the change in the traffic. As represented by the size of the vehicle fleet, total traffic seems likely to follow its historical growth at a faster rate than the population.

Fatality rates, however, can probably be expected to continue to fall over time. It seems likely that driving activity will increase more in conditions with lower risks (more urban than rural driving, for example, and at slower speeds because of congestion), and among drivers with lower than average risk, as driving activity continues to broaden demographically (involving more women and older people). Reductions should be reinforced by the lagged effects of recent safety measures, and by the impacts of anticipated new measures. It can

be expected that air bags will be introduced in all cars and light trucks, and that further vehicle standards will be introduced to improve crashworthiness (especially in side impacts) and crash avoidance (for example, through anti-lock brakes and hazards warning, or even automatic hazards avoidance). It can also be expected that highway safety will be improved by paving shoulders, removing roadside obstacles, and constructing further grade-separated highways.

In the longer term, the introduction of Intelligent Vehicle-Highway Systems holds the prospect of extraordinary improvements in safety (as well as traffic capacity). Once two-way vehicle communication systems are established for navigation (which will likely be broadly available in congested cities within 20 years), the development of vehicle control systems is likely to proceed swiftly, offering the possibility of vehicle queue control. Combined with the development of enhanced on-board vehicle control systems, and, ultimately, autonomous systems, these seem capable of greatly reducing crashes.

3. Values of Accident Losses

3.1 ESTIMATES OF LOSS COSTS IN ACCIDENTS IN CANADA

Most of the work to estimate accident losses has been done in relation to road safety.[47] A number of different cost items might be distinguished:

- damage to vehicles and other property;
- health care for victims;
- lost employment and other "work efforts" of victims;
- time and efforts of police and other emergency services;
- pain, suffering or mental anguish suffered by victims and others;
- lost home, family or community services of victims;

- legal and court proceedings to establish fault, compensation, and so on;

- administration of insurance claims; and

- efforts of family or friends in attending victims.

With a little ingenuity, the list can be extended considerably to include a number of other losses and irritations that affect the victim, the family, employer and social contacts, and that require social resources to correct.

Most of the items on the list would be difficult to identify and estimate, and some might be impossible to measure. The "subjective" costs of victims' pain and suffering obviously present the most problems, but a number of other items, such as losses of services in the home or other family and community services, are normally unpaid and are difficult to assess monetarily.

Transport Canada has attempted to estimate values for all of these losses, and show that three major items dominate (in this order): property damage, lost work, and health care costs. Costs of property damage are estimated from insurance company claims records, with allowances for unclaimed damage. Costs of lost work are estimated from durations of disability and average expectations of lifetime income, with allowance for unpaid efforts at alternative market rates. Health care costs are estimated primarily from payment records from the provincially owned motor-vehicle insurance administrations in Quebec and British Columbia.

Estimates of the losses (rounded) are shown in Tables 8(2)-17 to 8(2)-21, as total amounts for the year 1990, as averages per accident by severity, and as averages per victim by severity (the average accident including more than one victim, plus property damage).

Table 8(2)-17
ESTIMATED VALUES OF TOTAL LOSSES IN ROAD ACCIDENTS, 1990

Type of loss	Amount ($ billion)
Property damage	5.0
Lost work	3.5
Health care	0.5
Total	9.0

Source: J.J. Lawson, *The Valuation of Transport Safety*, updated by author to 1990.

Table 8(2)-18
ESTIMATED LOSSES PER ACCIDENT, 1990

Severity of accident	Loss per accident ($)
Fatal	400,000
Injury	25,000
Damage only	5,000

Source: Lawson, *The Valuation of Transport Safety*, updated by author to 1990.

Table 8(2)-19
ESTIMATED LOSSES PER VICTIM, 1990

Severity of injury	Loss per victim ($)
Fatal	330,000
Non-fatal	10,000

Source: Lawson, *The Valuation of Transport Safety*, updated by author to 1990.

Table 8(2)-20

ESTIMATED LOSSES PER ACCIDENT BY TYPE OF LOSS, 1990

Class of accident	Health care ($)	Work loss ($)	Property damage ($)	Total ($)	Number of accidents
Fatal	(few)	400,000	10,000	400,000	3,340
Injury	2,000–3,000	12,000	10,000	25,000	178,854
Damage only	nil	nil	5,000	5,000	650,000

Source: Lawson, *The Valuation of Transport Safety*, updated by author to 1990.

Table 8(2)-21

ESTIMATED TOTAL LOSSES IN ALL ROAD ACCIDENTS BY TYPE OF LOSS, 1990

(BILLIONS OF DOLLARS)

Class of accident	Health care	Work loss	Property damage	Total
Fatal	(few)	1.4	(few)	1.4
Injury	0.5	2.1	1.8	4.4
Damage only	nil	nil	3.2	3.2
Total	**0.5**	**3.5**	**5.0**	**9.0**

Source: Lawson, *The Valuation of Transport Safety*, updated by author to 1990.

3.2 HEALTH CARE LOSSES: WHO PAYS?

Surprisingly little information is available on the extent and costs of health care for victims of transportation accidents, partly because the health care system is more concerned with recording diagnoses and treatments than causes of ill-health, and partly because hospitals and provincial medical insurance schemes do not attribute treatment costs to individual victims, but average their costs per day and charge victims for the number of days treated.

The values in the tables come from Quebec and British Columbia, where the provincial motor-vehicle insurance agency reimburses the department of health for treatment of road accident victims. In both provinces, the agreed amount in each year is a lump sum estimated by the department of health as the costs it incurred.

The amounts in 1990 were about $1,250 per reported road accident victim in British Columbia, and about $2,500 per reported victim in Quebec.[48] Adjusting for a higher average severity of injury to victims in Quebec, the national average is estimated to be $1,500 to $2,000 per reported victim. In 1990, the total would be rounded up to about $500 million for the 263,000 reported victims. Note that this average per reported victim is much lower than the individual costs of treatment for those who received health care, because about 35% of all reported victims received no medical treatment, another 55% received only out-patient treatment, and only about 10% were admitted to hospital.

Of the total of about $500 million, the Quebec and British Columbia insurance corporations — through their policy-holders — paid nearly $200 million. In Ontario, since the introduction of "no-fault" motor-vehicle insurance in 1990, the entire amount has been paid from provincial medical insurance budgets — and that probably amounted to between $200 million and $220 million in 1990. (Previously, the provincial health agency was able to recuperate the costs of health care from vehicle insurance companies when their clients were found responsible, and operated a bulk payment agreement by which the companies paid a flat rate of 2.5% of liability insurance premiums to cover those health care costs.)

In Saskatchewan, the provincially owned motor-vehicle insurance corporation is held liable by the provincial health insurance systems for the health care costs of victims who are negligent in accidents, but those are a small minority of victims. (In Saskatchewan, the payment this year amounts to about $3 million.[49]) The rest of the cost is borne by provincial health insurance. In the remaining provinces, the private vehicle insurance companies can be held responsible for the health care costs of those found at fault (as used to be the case in Ontario). This must be done case by case, however, and so reimbursement is not pursued systematically — probably most often when costs are higher and negligence is more firmly established.

In summary, it seems probable that for road accident victims roughly as much as $300 million of health care costs are borne annually by health insurance plans, and about $200 million by motor vehicle owners (essentially only in Quebec and British Columbia).

For other modes, no information is available whether provincial health care authorities recover health care costs. It seems less likely that recovery would be achieved for these modes, because the assignment of responsibility is probably less formal than is the case with road accidents (where police normally determine responsibility, and fault-finding procedures are well established in insurance legislation or by customary practice). Therefore, it seems probable that health care systems and the people who pay for them meet all the costs of care for accident victims in these other modes. However, there are also many fewer casualties compared with those in road accidents. The total health care costs, in 1990, for road casualties (urban as well as interurban) related to 3,957 fatalities and 263,000 injuries. Comprehensive and comparable records of the number of injured victims in the other modes are not available, but their total annual number is likely much less than 1,000. The largest number would be in bus accidents, which subsection 2.3 suggests were about 170 annually from 1985 to 1987. The next largest group would be victims of train accidents. Transportation Safety Board records show that the ratio of injured victims to fatalities from 1981 to 1990 was fewer than five to one, in which case the annual number in accidents involving passenger trains and excluding grade crossing accident victims (counted as road accident victims) would be fewer than 80. For accidents involving aviation, in which about 60 people died annually during the decade, it seems likely that the ratio of injured to killed is very low (because aviation accidents are so severe). Finally, ferry accidents are so rare that fewer than one person was killed annually in the decade, and the number of injured was likely to be fewer than 10 per year.[50] Health care costs for all injured victims in the public modes would then have been less than $2 million in 1990, if costs per victim were the same as for road accident victims.

3.3 ALTERNATIVE VALUATIONS OF ACCIDENT LOSSES, FROM "WILLINGNESS TO PAY"

Academics have debated the appropriate "value of life" for a century or more. Most of the argument has centred on the value of improvements in safety brought by public investments. The predominant view among economists is currently that intangible benefits in benefit-cost analysis should be given money values based on what the beneficiaries would be willing to pay for them. The view of specialist, safety economists is also that the benefit from a safety improvement is the risk reduction gained by the population at risk, and that its value is whatever people would be willing to pay for the psychological satisfaction they gain.

From this viewpoint, the value of avoiding accidents and their consequences need bear no direct relationship to the costs of sustaining those consequences. Rather than valuing safety by adding up the costs of people dying, it proposes that we add up what the population at risk is willing to pay to reduce the specified chance of dying.

Researchers have considered the following sources:

- insurance premiums paid by individuals;
- court awards of compensation to accident victims;
- values of safety implied by previous government decisions;
- premiums received by workers in risky jobs;
- amounts paid by consumers for safety devices; and
- amounts individuals say they would pay for hypothetical risk reductions.

The first three sources are inappropriate for appraising safety improvements. Insurance premiums address only risks of personal financial losses, and cannot incorporate loss of a victim's own life or physical suffering. Court awards are circumscribed by law and

precedent, and tend to be paid in unrepresentative circumstances, in which negligence can be shown, and/or losses are large. Values implied by previous government decisions reveal what hindsight shows the government to have accepted, when rarely was the trade-off explicit, and shows major inconsistencies.

The other three potential sources are cases where individuals trade money for safety, and are considered to be legitimate approaches to finding "willingness to pay" for safety. Worldwide, only about 40 of these empirical studies have been undertaken.[51] It is very difficult to find credible situations in which safety is traded for money in an identifiable way — when the change in risk that is being purchased, and the amount of money involved, are obvious to both the purchaser and the researcher.

Most of these studies compare wage premiums paid for job risks. In these studies, the researcher normally has only some broad estimates of average risks existing in various industries, and must assume that each worker recognizes and trades precisely those risks in deciding where to work. That seems implausible, as does the presumption in the studies that the risk premiums are unaffected by bargaining conditions such as trade union power.

In studies of consumer purchases of safety devices, it is even more difficult to determine what risk reduction consumers believe they are obtaining. Researchers seldom find it possible even to obtain an objective estimate of the risk reduction involved. Such studies are, consequently, extraordinarily rare. The favoured alternative approach is to consider situations in which travellers trade time for safety, and to infer a value for safety from an assumed money value for their time. These add the complications of the great uncertainties in determining values of time to those of revealing the nature of the traded risk.[52]

Finally, the survey approach, asking people the values they would pay for hypothetical risk reductions, manages to avoid the problems of recognizing the risk changes involved, as these are specified in the

questions. It faces the criticism, however, that hypothetical responses might relate only poorly to behaviour, and it introduces a number of specific problems in respondents' ability to understand and manipulate small numerical risks.

The behavioural studies we reviewed provide estimates for the value of avoiding a death ranging from less than $200,000 to more than $50 million. The view of some economists[53] is that the best of these can be judged to centre on about $1 million to $3 million, and that such values should be used in benefit-cost analysis. The view of others[54] is that the results of the studies do not allow a confident finding of a central value, or schedule of values of different risks. They also believe there is currently no substitute for either using minimum values based on material losses (Tables 8(2)-17 to 8(2)-21), or obtaining a political judgement of the values of safety to use in benefit-cost analysis, based on the relative priority to be given to safety among other objectives of government action.

3.4 CURRENT PRACTICE AT TRANSPORT CANADA

The policy on valuing safety at Transport Canada has undergone a radical change, with adoption in 1992 of a single value for a death avoided of $1.5 million, in 1991 dollars. Recent practice differed substantially among different parts of the Department, with values in 1989 dollars varying from $310,000 in road safety evaluations to as high as $2.9 million in some aviation investment evaluations. The differences were not created by income differences in the victims (by mode), but resulted from different interpretations of the literature on willingness-to-pay valuations. The position taken for road safety evaluations was that willingness-to-pay research had not provided convincing estimates, so the value used was a minimum estimate based on material losses, while the value used in aviation evaluations reflected a judgement that some of the willingness-to-pay research provided defensible values.

The current position of Transport Canada's Economic Evaluation Branch is that a single value should be used throughout the Department, and that $1.5 million is appropriate.

3.5 RECENT FOREIGN PRACTICE

Values for transport safety are used routinely in many countries, particularly in road investment analysis. Recent official values of transport safety were as follows:

	Approximate $ Can., 1989
United States:	
Federal Highway Administration (FHWA)[55]	2,400,000
Federal Aviation Administration (FAA)[56]	2,500,000
Department of Transportation (DOT)	
General Counsel[57]	1,600,000
United Kingdom[58]	1,000,000
Australia[59]	480,000
Germany[60]	850,000
Finland[61]	950,000
France[62]	350,000
Sweden[63]	950,000

Values for road safety in most of the countries have been based on the measurable money losses, due to an admitted inability to reveal values in any other way. This is true in Australia, Germany, France, and, until recently, the United Kingdom. As these losses consist mainly of the earnings expected to be lost over a lifetime, most of the differences among the countries arise through differences in wage rates and discount rates. (Canada's Road Safety values were lower than most because of a higher discount rate.)

The value shown for the United Kingdom was the result of an explicit ministerial decision to nearly double the previous value because it gave insufficient priority in road improvement decisions to safety

compared with saving time and operating costs, and therefore favoured proposals that increased road traffic volumes or speeds at the expense of safety.[64] The value has subsequently been argued to represent a reasonable median value from the willingness-to-pay research.[65]

The value shown for the U.S. DOT General Counsel also reflects a political decision in 1986 on the minimum value to be defended in public by that department. It is now superseded at FHWA and FAA by the higher values recently proposed by those agencies, on the basis of a consultant's assessment that the research evidence converges to those values.

ENDNOTES

1. The term "casualty" refers to either death or injury.

2. "Risk" is used to refer to a **rate** of accidents or casualties per unit of traffic (for example, vehicles, veh-km or pass-km).

3. Total car/light-truck highway traffic is estimated at 210 billion pass-km in 1991. Transferring 1% of that, or 2.1 billion pass-km, with an average risk of 13 deaths per billion pass-km would save about 27 road deaths, while if it achieved the average risk for Levels 1 and 2 air carriers combined, of 0.13 deaths per billion pass-km, expected aviation deaths would rise by only 0.27.

4. A particularly interesting recent comparison of risks between road and air suggests that a typical U.S. business traveller who is sober, in a large car, in daylight, on limited-access highways faces a **lower** risk than on a scheduled flight for distances up to 1 000 km! (L. Evans, M.C. Frick and R.C. Schwing, "Is it safer to fly or drive?," *Risk Analysis* 10(2) (1990), pp. 239–246).

5. Passenger-kilometres reported by Statistics Canada are for carriers of Levels 1 to 4, so this 3.5% share actually represents carriers of Levels 3 and 4, rather than 3 to 6. However, it is expected that the passenger traffic carried by Levels 5 and 6 is so small as to be almost negligible in the total for Levels 3 to 6, and in the estimation of fatality rates per pass-km for this class of carriers. In support of that contention, it can be noted that prior to 1981, Statistics Canada reported pass-km for Level 5 carriers on unit toll services, and that, in 1980, those carriers provided less than 0.7% of the pass-km reported on services by carriers of Levels 3 and 4, and that the proportion had declined substantially since 1976 (Statistics Canada, *Air Carrier Operations in Canada*, Catalogue No. 51-002, 1975–1981 issues, Table 1 or 1.2).

6. Personal communication between a Transportation Safety Board official and Royal Commission staff.

7. The crash of a Nationair aircraft in Jeddah in 1991, which claimed 261 lives, will substantially change the long-term fatality rates estimated for Canadian carriers as a whole, and that for the Level 2 carriers quite dramatically. The 10-year average passenger fatality rate per billion pass-km for Level 2 carriers will rise from 0.7 to about 4.6, and the combined rate for Levels 1 and 2 from about 0.1 to 0.6.

8. U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970*, Series Q, Air Transportation (Washington D.C.: 1976) and *Statistical Abstract of the United States* (Washington, D.C.: 1970 to 1990).

9. G. Dionne, R. Gagné and C. Vanasse, *A Statistical Analysis of Airline Accidents in Canada 1976-87* (Montreal: Univ. of Montreal, Centre for Research on Transportation, May 1991).

10. For summaries see: D.L. Golbe and L. Lazarus, "Summary and Policy Implications for Air," *Transportation Deregulation and Safety, Conference Proceedings* (Northwestern University Transportation Center, June 1987), pp. 513–17; L.N. Moses and I. Savage, "Summary and Policy Implications, The Airline Industry," in *Transportation Safety in an Age of Deregulation*, eds. L.N. Moses and I. Savage (New York: Oxford University Press, 1989), pp. 308–320; L.N. Moses, and I. Savage, "Aviation Deregulation and Safety: Theory and Evidence," *Journal of Transport Economics and Policy*, May 1990, pp. 171–88.

11. T.G. Moore, "The myth of deregulation's negative effect on safety," in *Transportation Safety in an Age of Deregulation*, eds. L.N. Moses and I. Savage, pp. 8–27.

12. C.V. Oster, and C.K. Zorn, "Is it still safe to fly?," in *Transportation Safety in an Age of Deregulation*, pp. 129–152.

13. Moore "The Myth Of," Table 2.1, p. 14.

14. Oster and Zorn, "Is it still safe to fly?," Table 10.3.

15. See Oster and Zorn "Is it still safe to fly?," Table 10.4; and R.J. Gordon, "Productivity in the Transportation Sector," *NBER Working Paper No. 3815* (Cambridge, Mass.: National Bureau of Economic Research, August 1991).

16. L.F. Bylow and I. Savage, "The Effect of Airline Deregulation on Automobile Fatalities," *Accident Analysis and Prevention* 23 (5), (1991), pp. 443-52.

17. Problems of interpretation mean that it is possible that some intercity bus accidents and their victims were not identified.

18. As noted in Volume 1, Chapter 13, these ferries comprise the marine ferries on the west and east coasts, together with the crossings of the St. Lawrence tidal estuary in Quebec, and the Tobermory-South Baymouth service in Lake Huron.

19. Personal communication from Transportation Safety Board staff to Royal Commission staff, Dec. 2, 1991.

20. It is not possible from the available evidence to observe whether the annual fatalities were changing through the decade. Ferry traffic (measured by number of passengers carried) grew substantially through the decade, but no equivalent growth in fatalities can be seen in Table 8(2)-14.

21. P. Gutoskie, *Road Accident Statistics in Canada — 1989*, Report TP 10812, Road Safety Directorate (Ottawa: Transport Canada, March 1991), Table A14. The subsequent publication for 1990 records the number of "rural" fatalities as 2,654 (TP 11230, Jan. 1992).

22. Royal Commission staff estimate, based on 420,000 heavy trucks assumed in use in 1989, and kilometres per vehicle as estimated in F. Nix, M. Boucher and B. Hutchinson, "Road Costs," in Volume 4 of this report.

23. Note that Nix et al. estimate that heavy trucks travel some 2.5 times as many kilometres per vehicle per year as cars and light trucks (44,000 compared with 17,600), in which case their rate of fatal accident involvement per vehicle-kilometre can be inferred to be only 40% of that for cars and light trucks (or 1 ÷ 2.5).

24. E.R. Welbourne and P. Gutoskie "Heavy Truck Accidents, Casualties and Countermeasures," *Proceedings of the Canadian Multidisciplinary Road Safety Conference VI*, (Fredericton, N.B.: University of New Brunswick, 1989), pp. 183–93.

25. Transportation Association of Canada, Interjurisdictional Committee on Vehicle Weights and Dimensions, *Summary of Weight and Dimension Regulations for Interprovincial Operations, Resulting from the Memorandum of Understanding on Interprovincial Weights and Dimensions* (Ottawa: TAC, Sept. 1989).

26. See, for example, G. Sparks et al., *The Safety Experience of Large Trucks in Saskatchewan* (Saskatchewan Highways and Transportation, Spring 1988).

27. Transportation Research Board, "Twin Trailer Trucks," *Special Report 211* (Washington, D.C.: National Research Council 1986).

28. R.P. Schweitzer, "The Myth of Economic Deregulation and Safety in the U.S. Motor Carrier Industry," *Transportation Deregulation and Safety* (Northwestern Univ. Transportation Center, June 1987), pp. 693–710.

29. U.S. DOT, National Highway Traffic Safety Administration, "A Summary of Fatal and Nonfatal Crashes Involving Medium and Heavy Trucks in 1988," draft report, February 1990.

30. Much of the following description is derived from J.J. Lawson, *Long Term Trends in Road Safety*, Report TP 9417 (Ottawa: Transport Canada, July 1988).

31. Traffic in vehicle-kilometres is estimated in Canada only approximately from fuel sales. Evidence from countries with more direct measures of vehicle-kilometres confirms that fatalities grew faster than traffic in these periods; see European Conference of Ministers of Transport, *Statistical Report on Road Accidents*, Paris, annual.

32. M. Gaudry, "DRAG, un modèle de la Demande Routière, des Accidents et de leur Gravité, appliqué au Québec de 1956 à 1982," Publication #359, (Montreal: Univ. of Montreal, Centre for Research on Transportation, Univ. of Montreal, October 1984).

33. See, for example, (in chronological order) R.J. Smeed, "Some Statistical Aspects of Road Safety Research," *J Royal Stat. Soc.*, A(1) (1949), pp. 1–34; J.G.U. Adams, *Risk and Freedom: the Record of Road Safety Regulations* (Cardiff: Transport Publishing Projects, 1985); J.G.U. Adams, "Smeed's Law: Some Further Thoughts," *Traffic Engineering and Control* 28(2) (Feb. 1987), pp. 70–73; and J. Broughton, "Predictive Models of Road Accident Fatalities," *Traffic Engineering and Control* 29 (May 1988), pp. 296–300.

34. See, for example, D.C. Andreassen, "Linking Deaths with Vehicles and Population," *Traffic Engineering and Control* 26(11), Nov 1985, pp. 547–9.

35. S. Oppe, M.J. Koornstra and R. Roszbach, "Macroscopic Models for Traffic Safety," *International Symposium of Traffic Safety Theory and Research Methods, Session 5*, (Leidschendam, The Netherlands: Institute for Road Safety Research (SWOV), April 1988); S. Oppe, "The Development of Traffic and Traffic Safety in Six Developed Countries," *Accident Analysis and Prevention* 23(5) (1991) pp. 401–412; S. Oppe, "Development of Traffic and Traffic Safety: Global Trends and Incidental Fluctuations," *Accident Analysis and Prevention* 23(5) (1991) pp. 413–422.

36. For a specific example, see K. Rumar, U. Berggrund, P. Jernberg and U. Ytterbom, "Driver Reaction to a Technical Safety Measure — Studded Tyres," *Human Factors*, 18 (1976), pp. 443–54; for a recent major summarization of the issues, see Organisation for Economic Co-operation and Development, Road Transport Research, *Behavioural Adaptation to Changes in the Road Transport System* (Paris: OECD, 1990).

37. G.S. Wilde, "The Theory of Risk Homeostasis: Implications for Safety and Health," *Risk Analysis* 2 (1982), pp. 209–25.

38. L. Evans, "Human Behaviour Feedback and Traffic Safety," *Human Factors* 27 (1985), pp. 555–76.

39. E. Hauer, "On the Estimation of the Expected Number of Accidents," *Accident Analysis and Prevention* 18 (1) (1986), pp. 1–12.

40. See summary of research in P.J. Cooper, *Benefit/Cost Assessment of Some Major Traffic Accident Countermeasures in British Columbia* (Vancouver: Insurance Corporation of British Columbia, Jan. 1985).

41. See summary in R.W. Crandall et al., *Regulating the Automobile* (Washington: The Brookings Institution, 1986).

42. See summary in U.S. Department of Transportation, National Highway Traffic Safety Administration, *Effectiveness of Safety Belt Use Laws: A Multinational Examination*, Report DOT HS 807018 (Washington, D.C.: DOT, Oct. 1986).

43. See, for example, Australia, Federal Office of Road Safety, *Drink Driving Controls in Australia* (Canberra: Dept. of Transport, Aug. 1986).

44. See U.S. Department of Transportation, National Highway Traffic Safety Administration, *Study of the Effectiveness of State Motor Vehicle Inspection Programs, Final Report*, Report HS 807468 (Washington, D.C.: DOT, Sept. 1989).

45. See J.R. Stock et al., *Evaluation of Safe Performance Secondary School Driver Education Curriculum Demonstration Project, Final Report* (Springfield, VA: National Technical Information Services, 1983).

46. Organisation for Economic Co-operation and Development, *Road Research Programme: Road Safety Campaigns: Design and Evaluation* (Paris: OECD, Dec. 1971).

47. For a review of recent literature, see J.J. Lawson, *The Valuation of Transport Safety*, Report TP 10569 (Ottawa: Transport Canada, Economic Evaluation Branch, May 1989), on which much of the following discussion is based.

48. Total payments for the year were obtained through personal communication with staff of the Insurance Corporation of British Columbia and Société de l'Assurance Automobile du Québec, and totals were divided by number of reported victims to obtain the above averages. Total payment in Quebec was reported for 1985 in B. Bordeleau, *Évaluation des coûts de l'insécurité routière au Québec* (Quebec: Régie de l'assurance automobile du Québec, Dec. 1988), p. 43.

49. Personal communication with staff of SGI Corp.

50. Transportation Safety Board, *Annual Report 1990* (Ottawa: Supply and Services Canada, 1991), records (Table A-2) some 1,132 injured and 168 killed in all accidents involving Canadian commercial vessels (including accidents aboard ships), during 1981–1990, a ratio of 6.7 injured to each death.

51. A number of which are reviewed in some detail in Lawson, *The Valuation of Transport Safety*, on which the following assessment is based.

52. For summaries of efforts to estimate the value of time, see Lawson, JJ, *The Value of Travel Time for Use in Economic Evaluations of Transport Investment: An Assessment of the Research Findings*, Report TP 10569 (Ottawa: Transport Canada, Economic Evaluation Branch, March 1989); or W.G. Waters II, *The Value of Time Savings for the Evaluation of Highway Investments in British Columbia* (Vancouver: University of British Columbia Centre for Transportation Studies, 1992).

53. Prominently Miller; see, for example, T.R. Miller, S. Luchter and C.P. Brinkman, "Crash Costs and Safety Policy," *Accident Analysis and Prevention* 21(4) (1989), pp. 303–16.

54. For example, Lawson, *The Valuation of Transport Safety*.

55. U.S. Department of Transportation, Federal Highway Administration, *Technical Advisory T 7570.1: Motor Vehicle Accident Costs* (Washington, D.C.: DOT, June 30, 1988).

56. Personal communication with staff of U.S. Dept. of Transportation, Federal Aviation Administration.

57. Memorandum from General Counsel, Office of the Secretary, U.S. Dept. of Transportation, to "Regulation Council Members," on the subject of "Value of a Life," dated April 10, 1986.

58. U.K. Dept. of Transport, *Values for Journey Time Savings and Accident Prevention* (London: Dept. of Transport, 1987).

59. L.A. Steadman and R.J. Bryan, *Costs of road accidents in Australia*, Occasional Paper 91 (Canberra: Bureau of Transport and Communications Economics, 1988).

60. R. Krupp, *Extent, Severity and Economic Costs of Permanent Injuries Caused in Road Accidents* (Bergisch Gladbach: Bundesanstalt für Strassenwesen, May 1984), updated by personal communication from Dr. Krupp.

61. N. Halla, A. Tevajarvi, *User Costs in Road Traffic 1988* (Helsinki, Finland: Roads and Waterways Administration, April 1988).

62. H. Duval, *La valeur monétaire d'une vie humaine*, Cahier d'Étude 58 (Arceuil: Organisme national de sécurité routière, March 1983).

63. Vagverket, Serviceavdelning Planering och Projectering: *Objektanalys 18. Effektkatalog Vag- och gatuinvesteringar* (Borlange, Sweden: Vagverket (Swedish Road Administration), July 1986).

64. Quoted in "Values Placed on Road Deaths," *Traffic Engineering and Control* 29 (July/Aug. 1988), p. 423.

65. M.Q. Dalvi, *The Value of Life and Safety: A Search for a Consensus Estimate* (London: Dept. of Transport, 1988).

NOTES TO CHAPTER 9: LEGISLATION, REGULATIONS AND RELATED DEVELOPMENTS AFFECTING PEOPLE WITH TRANSPORTATION-RELEVANT DISABILITIES

INTRODUCTION

These notes provide background information on the accessibility of transportation to people with disabilities. The topics covered include:

1. the current legislative base;

2. National Transportation Agency orders and regulations;

3. major events, studies and inquiries; and

4. a comparison of U.S. and Canadian legislation and regulations designed to improve transportation accessibility.

1. LEGISLATIVE BASE

Early in Chapter 9, Volume 1, the current situation relating to Canadians with transportation-relevant disabilities is described. One key to understanding this situation is a knowledge of the legislation that provides the principles to be observed in improving access to transportation services for travellers with disabilities. This section quotes these legislative provisions and briefly describes how they interrelate.

1.1. THE *NATIONAL TRANSPORTATION ACT, 1987*

The *National Transportation Act, 1987*[1] (NTA, 1987) applies to all federally regulated modes of transportation. For passenger services this includes all air, most rail, and some bus and marine services. Paragraph 3(1)(g) of the Act provides that:

> each carrier or mode of transportation, so far as practicable, carries traffic to or from any point in Canada under fares, rates and conditions that do not constitute . . . an undue obstacle to the mobility of persons, including those persons who are disabled. . . .

The NTA, 1987 also provides direction to the National Transportation Agency concerning its specific role in improving access to transportation services for people with disabilities. This direction took effect through the July 1988 amendments to the Act that read as follows:

63.1(1) The [National Transportation] Agency may, with the approval of the Governor in Council, make regulations for the purpose of eliminating undue obstacles in the transportation network governed by this Act to the mobility of disabled persons, including regulations respecting

(a) the design, construction or modification of, and the posting of signs on, in or around, means of transportation and related facilities and premises, including equipment used in them;

(b) the training of personnel employed at or in those facilities or premises or by carriers;

(c) tariffs, rates, fares, charges and terms and conditions of carriage applicable in respect of the transportation of disabled persons or services incidental thereto; and

(d) the communication of information to disabled persons.

(2) Regulations made under subsection (1) incorporating standards or enactments by reference may incorporate them as amended from time to time.

(3) The Agency may, with the approval of the Governor in Council, make orders exempting specified persons, means of transportation, services or related facilities and premises from the application of regulations made under subsection (1).

63.2   The Agency and the Canadian Human Rights Commission shall co-ordinate their activities in relation to the transportation of disabled persons in order to foster complementary policies and practices and to avoid jurisdictional conflicts.

63.3(1) The Agency may, of its own motion or on application, inquire into a matter in relation to which a regulation could be made under subsection 63.1(1), regardless of whether such a regulation has been made, in order to determine whether there is an undue obstacle to the mobility of disabled persons.

(2) Where the Agency is satisfied that regulations made under subsection 63.1(1) that are applicable in relation to a matter have been complied with or have not been contravened, the Agency shall determine that there is no undue obstacle to the mobility of disabled persons.

(3) On determining that there is an undue obstacle to the mobility of disabled persons, the Agency may order the taking of appropriate corrective measures, or the payment of compensation for any expense incurred by a disabled person arising out of the undue obstacle, or both.

On June 18, 1992, an omnibus Bill (C-78) was passed by Parliament. It amended six Acts, including section 3 of the NTA, 1987. The words "accessible" and "persons with disabilities" were added to the introductory statement of section 3, which is the key statement of general policy in the Act. The statement now reads as follows:

It is hereby declared that a safe, economic, efficient, and adequate network of viable and effective transportation services <u>accessible to persons with disabilities</u> . . . is essential to serve the transportation needs of shippers and travellers, <u>including persons with disabilities</u>. . . . [addition underlined]

1.2 THE *CANADIAN CHARTER OF RIGHTS AND FREEDOMS* AND THE *CANADIAN HUMAN RIGHTS ACT*

Section 63.2 of the NTA, 1987, directs the National Transportation Agency to coordinate its efforts on behalf of persons with disabilities with the efforts of the Canadian Human Rights Commission. In questions relating to persons with disabilities, the judicial system, including the Canadian Human Rights Commission, is influenced by the equity provisions of the *Canadian Charter of Rights and Freedoms*[2] and the *Canadian Human Rights Act*.[3] The key section of the Charter reads:

Equality Rights

15.(1) Every individual is equal before and under the law and has the right to the equal protection and equal benefit of the law without discrimination and, in particular, without discrimination based on race, national or ethnic origin, colour, religion, sex, age or mental or physical disability.

(2) Subsection (1) does not preclude any law, program or activity that has as its object the amelioration of conditions of disadvantaged individuals or groups including those that are disadvantaged because of race, national or ethnic origin, colour, religion, sex, age or mental or physical disability.

The key sections of the *Canadian Human Rights Act* stipulate:

General

3.(1) For all purposes of this Act, race, national or ethnic origin, colour, religion, age, sex, marital status, family status, disability and conviction for which a pardon has been granted are prohibited grounds of discrimination.

(2) Where the ground of discrimination is pregnancy or child-birth, the discrimination shall be deemed to be on the ground of sex.

Discriminatory Practices

5.   It is a discriminatory practice in the provision of goods, services, facilities or accommodation customarily available to the general public

   (a) to deny, or to deny access to, any such good, service, facility or accommodation to any individual, or

   (b) to differentiate adversely in relation to any individual,

   on a prohibited ground of discrimination.

1.3 HOW THE SYSTEM WORKS

Although subsection 63.3(1) of the NTA, 1987 gives the National Transportation Agency the power to initiate inquiries into matters that relate to a regulation or a potential regulation, until recently the Agency normally limited its activities to the investigation of possible undue obstacles. In these cases, an individual had to have experienced an unsatisfactory situation before registering a complaint.

Under the *Canadian Charter of Rights and Freedoms* and the *Canadian Human Rights Act*, a traveller with a disability must have attempted to travel and been denied access in order to have a case. As pointed out in Chapter 9 of Volume 1 of this report, it is not sufficient to know that one would be refused access to a mode of transportation — a person must have been denied access before having recourse to the Canadian Human Rights Commission.

2. NATIONAL TRANSPORTATION AGENCY ORDERS AND REGULATIONS

This section outlines the key initiatives undertaken by the National Transportation Agency to improve the accessibility of transportation for people with disabilities. Since the NTA, 1987 was amended in July 1988, the Agency has resolved over 50 complaints about possible undue obstacles and has initiated four inquiries.

2.1 ORDERS AND DECISIONS

In response to complaints lodged with the National Transportation Agency, the Agency issued several orders and decisions to improve accessibility. For example:

- Canadian Partner (Ontario Express Ltd.) was ordered to reverse its policy of refusing to carry certain persons with disabilities on small aircraft (September 1990).

- Air Canada was instructed to make wheelchairs available on all aircraft that are equipped to store them and to assist those people who require help in using the nearest on-board washroom (July 1991).

- McIntosh Limousine Service at Lester B. Pearson International Airport in Toronto was ordered to provide transportation to all passengers with disabilities and to inform all of its drivers of this policy (August 1991).

- In June 1991, Air Canada and Canadian Airlines International were ordered to provide a reasonable number of copies of their safety briefing material in both braille and large print, in addition to the personal safety briefing provided to passengers with visual disabilities, effective August 1, 1992. The carriers were further required to show why they should not also provide safety information on audio cassettes. The Agency accepted the carriers' arguments that it is not operationally possible to provide such information on audio cassettes at this time.

2.2 REGULATIONS

On March 21, 1992, the National Transportation Agency published proposed regulations regarding transportation access for persons with disabilities in the *Canada Gazette, Part I.* The final regulations are proposed to become effective one year after they have been

published in the *Canada Gazette, Part II*. As of July 31, 1992, they had not been published in Part II. The proposed regulations comprise two components:

- amendments to the *Air Transportation Regulations* "to regulate the domestic carriage of persons with disabilities in aircraft of 30 or more passenger seats relating to services to be provided to persons with disabilities;" and

- Personnel Training Regulations for the Assistance of Disabled Persons, which would apply to personnel in the transportation network governed by the *National Transportation Act, 1987* (all domestic air, rail, marine passenger carriers and Newfoundland's Roadcruiser bus service).

2.2.1 *Air Transportation Regulations* — Amendment

The proposed amendments to the *Air Transportation Regulations* specify, step by step, the kinds of assistance that must be provided to travellers with disabilities from the time they register at the check-in counter until they enter the general public area after retrieving checked baggage. The amendments also specify the way to handle special aids, such as wheelchairs, that are required for the mobility and well-being of a traveller.

Although these regulations in general apply to aircraft with 30 or more passenger seats, if an aircraft has fewer than 60 passenger seats, and its design prevents carrying an electric or manually oper-ated wheelchair or three-wheel scooter, the air carrier is not required to carry the special aid. The air carrier, however, must advise the trav-eller about transportation arrangements that are available for the aid.

Where there is a conflict between the proposed regulations and any safety regulations made under the *Aeronautics Act*, the latter prevail.

The description of the proposed regulations indicates that they address areas agreed upon by organizations representing people

with disabilities and air carriers. An important feature of the regulations is the guarantee of uniformity of services throughout the country for travellers with disabilities.

The description also acknowledges that the largest impact upon carriers will be on the small and medium-sized operators (about 25 in Canada) that will need to establish comprehensive programs for responding to people with disabilities. The regulations, however, do not require alterations to transportation equipment. Because the amendments apply only to procedures, the description states that "it is not anticipated that carriers will incur additional operating expenses."

The National Transportation Agency also noted in its general description of the regulations that the original set of proposals sent to interested parties in July 1988 "also referred to special air fares for the assistants of passengers with disabilities, and for additional seats required to accommodate a disability. The section on special air fares has been removed to permit further consultation."

In Chapter 9 of Volume 1 of this report, the Royal Commission recommends that:

> When the National Transportation Agency or the carrier concludes that, for safety reasons, an attendant is needed during a trip to assist an individual with a disability, the attendant's fare be borne by the carrier. Otherwise, the traveller should bear the cost. To ensure consistency, carriers should coordinate their policies in this area.
> (Recommendation 9.8)

Section 154 of the Agency's proposed regulations states that "an air carrier shall accept the determination made by or on behalf of a person that the person does not require any extraordinary service during a flight." "Extraordinary service" is defined as "any service related to a disability that is not required by [the proposed regulations] to be provided by an air carrier or any service that is not normally provided by an air carrier."

2.2.2 Personnel Training Regulations

This set of regulations applies to personnel employed by carriers in all modes of transportation and by owners, operators and lessees of passenger transportation networks governed by the Act, every operator of a terminal, including personnel, and agents who provide transportation-related services such as security, parking, car rentals, baggage handling and, in the case of air travel, ground transportation from the terminals. Exempt from the regulations are small air carriers whose gross annual revenues are less than $250,000 or whose operations are limited solely to serving the needs of a lodge operation, and owners, operators or lessees of air terminals where less than 10,000 passengers were enplaned and deplaned during the preceding year.

The definition of "carrier" used in the proposed regulations restricts the application of the regulations to Canadian citizens or permanent residents and governments in Canada or their agents. It also applies to any entity that is controlled in fact by Canadians having at least 75 percent of the voting interests, and that operates a passenger transportation service within and from Canada.

As with the amendments to the *Air Transportation Regulations*, the Agency is aiming for uniform training standards across the country so travellers with disabilities will know what to expect during any Canadian trip. Essentially, the training of carrier personnel is to be at a level appropriate for the requirements of their jobs and should emphasize:

(a) knowledge of the policies and procedures of the carrier and operator with respect to a person with a disability, including relevant regulatory requirements;

(b) recognizing those disabilities most likely to need special services, and knowing the responsibilities on the part of the carrier and operator in relation to those disabilities, such as the level of assistance, methods of communication, and aids or devices generally required by a person with a disability; and

(c) acquiring the necessary skills to assist a person with a disability, by knowing the role of the assistant as well as the needs of a person travelling with a service-animal, including the role and the needs of that animal.

In addition, applicable carrier personnel are to be trained in the areas of providing physical assistance to passengers with disabilities and handling mobility aids (including disassembling and assembling) and special equipment.

Carriers and terminal operators are required to file a description of their training programs, in a form set out in the schedule included in the regulations. This description must be filed with the Agency when the regulations come into force, that is, one year after their publication in Part II of the *Canada Gazette*.

Because the Agency's proposed training regulations are not yet in effect, the Royal Commission recommends in Chapter 9 of Volume 1 that:

> Carriers ensure that personnel who are in a position to assist travellers with disabilities be trained to deal with such passengers with sensitivity and understanding. (Recommendation 9.9)

2.3 OTHER PROPOSED REGULATORY INITIATIVES OF THE AGENCY[4]

2.3.1 Special Air Fare Policy

At the same time that the Agency prepared the proposed revisions to the *Air Transportation Regulations* discussed earlier, it also developed a special air fare policy. The regulations relating to this policy for aircraft with 30 or more seats have been separated from the other air regulations, and additional consultations are being held with the Air Transport Association of Canada, and with groups representing people with disabilities. It should be noted, however, that in approving draft regulations the Agency has determined that it is an undue

obstacle to the mobility of people with disabilities to charge for the seat used by an attendant needed to provide services additional to those provided by the carrier, or to charge for additional seating that is needed to accommodate the passenger because of a disability. The current expectation is that the proposed regulations on special fares will be submitted to the Minister of Transport in autumn 1992.

2.3.2 Terms and Conditions of Carriage in Small Aircraft

Agency staff is currently completing an inquiry report into the manner in which carriers operating small aircraft serve people with disabilities. The report is expected to make recommendations on proposed regulations and will be provided to the industry for comment. The regulations will be for small aircraft (under 30 seats) and will cover services, fares for attendants, and fares for additional seats required to accommodate a passenger because of a disability. The Agency is expected to submit the regulations to the Minister early in 1993.

2.3.3 Terms and Conditions of Carriage in Other Federal Modes of Transportation

These proposed regulations will standardize the services provided to passengers with disabilities in modes of transportation (other than air) that are under federal jurisdiction. The proposals are being developed in consultation with an advisory committee representing people with disabilities, industry and federal government departments, including Transport Canada. The regulations are expected to be submitted to the Minister late in 1992.

2.3.4 Multimodal Equipment Accessibility

The proposed regulations will cover accessibility features in transportation equipment for all modes of transportation under federal jurisdiction. As for regulations concerning the terms and conditions of carriage, these proposals are being developed in consultation with an advisory committee representing all of the relevant parties. Two inquiries — one on ferries, the other on extra-provincial motor coaches — are currently under way and their results will be taken

into consideration in the redrafting of the equipment standards. When these standards are amended, they will be distributed to the advisory committee members for comment before being submitted for Agency approval. The proposed regulations (with the exception of ones dealing with extra-provincial motor coaches) will be submitted to the Minister of Transport at the end of 1992.

2.3.5 Communication of Information to People with Disabilities

This initiative is expected to standardize, in all transportation modes under federal jurisdiction, the way information is provided to people with sensory or cognitive impairments. Agency personnel are currently developing draft regulations for consideration within the Agency. It is expected that these will be submitted to the Minister of Transport during the summer of 1993.

2.3.6 Accessibility of Transportation Facilities (Terminals)

Agency staff are currently considering draft standards developed by Transport Canada, as well as the Canadian Standards Association Barrier-Free Design Standards, to determine how they can be incorporated into a regulatory proposal covering terminals in all modes under federal jurisdiction. It is expected that the proposal will be submitted to the Minister of Transport during the fall of 1993.

3. Major Events, Studies and Inquiries

The following section presents further details on major developments relating to transportation accessibility.

3.1 INDEPENDENCE '92

This major international conference was held in Vancouver from April 22 to 25, 1992. Its theme was "Self-Determination by Persons with Disabilities." The conference included an exposition whose centrepiece was "Independence Street," featuring an accessible bus as well as buildings and sidewalks that were designed to be very

accessible. The conference concluded the United Nations Decade of Disabled Persons, giving people with disabilities and their representatives the opportunity to celebrate the accomplishments of the past decade and prepare for future initiatives.

3.2 CANADA COACH LINES DEMONSTRATION PROJECT[5]

A major demonstration project of accessible intercity busing commenced in October 1989 in the Kitchener to Niagara Falls corridor in Ontario. Although some experience in providing intercity accessible bus transportation had been gained in Newfoundland since 1985, an additional demonstration project was required to assess the demand for accessible intercity bus service and to collect information concerning the economics of such a service.

Canada Coach Lines (CCL) was the only bus company that expressed an interest in offering such a service and, therefore, was awarded a contract by Transport Canada for the demonstration project.

The service is scheduled to continue for three years. It operates in a 180-kilometre corridor from Kitchener to Cambridge, Hamilton, St. Catharines and Niagara Falls serving a population of approximately 900,000. Within this corridor, more than 13,600 people with disabilities had registered to use the local para-transit service. These registrants made up the minimum potential market for the demonstration project.

All scheduled services within the corridor are provided by accessible buses that have the capacity to carry two passengers in wheelchairs. Although not a requirement, passengers are encouraged to reserve their trips in advance to ensure that space is available. Reservations can be made from anywhere in the corridor by means of a toll-free number.

3.2.1 Key Results of the First 21 Months

Users: When surveyed, travellers with disabilities who used the intercity bus expressed a high level of satisfaction with the service. All users stated that they would continue to use the service. Two thirds said that they had taken more intercity trips because the service was available and a quarter said that they would not have travelled otherwise.

The total usage of the service, however, was very low. During the first 21 months, only 242 trips were made by people with disabilities, an average 12 trips per month. Only 41 people used the service, and two of these made 47 percent of all the trips. Thus, only about 0.3 percent of the potential market took advantage of the service, and the trips made by people with disabilities represented only approximately 0.04 percent of the total trips taken.

Operations: The accessible service has had little effect on CCL's operations. Because the number of disabled travellers has been relatively low, the additional effort required to book reservations and to coordinate transfers and other activities has not placed a significant burden on the operations staff. During the first 21 months, there were only 13 incidents that affected the operation of the service and none of these was major.

CCL Personnel: Canada Coach Lines developed a one-day training program for the personnel who would be serving passengers with disabilities. In a September 1990 survey of drivers and dispatchers, 90 percent stated that they believed they had been adequately trained. Four drivers indicated that they had experienced some difficulty in understanding some passengers' speech, which might suggest that future training should include techniques for dealing with the problem.

Vehicles: During the first 21 months, the lifts on the buses malfunctioned 26 times — resulting in minor delays, but all passengers were carried safely. It was found that the accessible buses require a higher

level of maintenance than similar non-accessible buses. This is due mainly to the specialized equipment, especially the lift, as well as to increased brake wear, apparently caused by the weight of the lift and additional equipment. During the first year of the demonstration, maintenance costs averaged 7 cents per kilometre for the accessible coaches, compared with 2.5 cents for the non-accessible coaches. However, maintenance costs were highest during the first six months and have since decreased.

Marketing: When the demonstration project was initiated, major promotional efforts were made to inform potential customers of the existence of the service. Despite these activities, the service has not achieved a high level of market penetration. Brochures distributed through consumer organizations and local para-transit services appear to be the most effective way to inform potential users about the service.

Financial Data: During the first 21 months, the total cost of the demonstration was $338,800, of which $240,000 came from Transport Canada, $1,250 came from travellers with disabilities, and the remainder from Canada Coach Lines. Transport Canada paid for the lifts, the Washington transfer chairs and a portion of the marketing costs. CCL covered the toll-free telephone line, the personnel training costs, maintenance, and a portion of the marketing costs.

3.2.2 Supplementary Comments

In their submissions to the Royal Commission, some groups representing people with disabilities criticized the choice of location for the demonstration project, suggesting that Toronto should have been included. While use by people with disabilities has not been very high, Transport Canada has indicated that the route used for the demonstration is fairly representative of many routes in Canada. In addition, Canada Coach Lines is not licensed to operate into or out of Toronto.

3.3 INTERIM REPORT OF THE INQUIRY INTO LEVEL OF ACCESSIBILITY OF FERRY SERVICES

On March 19, 1991, the National Transportation Agency appointed three of its officers to "inquire into . . . whether the equipment and services offered by ferry companies under federal jurisdiction constitute undue obstacles to the mobility of persons with disabilities and make recommendations for the removal of such undue obstacles as they may discover."[6] These officers contacted major associations of, and for, people with disabilities, ferry operators, and provincial and federal governments. They met with representatives of many of these organizations and inquired into difficulties in gaining access to the vessels, accessibility to services on vessels, the awareness and training of ferry personnel, aspects of carriers' fare policies governing travellers with disabilities and the costs of providing accessibility. The inquiry officers also made their own examinations of some frequently used services.

Among the ferry services visited were BC Ferries (Canada's largest ferry operator but provincially regulated since it operates within British Columbia), Marine Atlantic Inc., Northumberland Ferries Limited, Société des traversiers du Québec and Coopérative de transport maritime et aérien (CTMA). The inquiry team also held discussions with providers of provincial services in Newfoundland and British Columbia.

The inquiry reached the following conclusions[7] in its interim report dated January 17, 1992:

1. Overall, carriers are making efforts to improve accessibility; Marine Atlantic especially is making efforts and in doing so benefits from its on-going consultations with an Advisory Accessibility Committee.

2. There are no national standards across Canada and the inquiry officers believe that inconsistencies in levels of accessibility pose obstacles to the mobility of persons with disabilities.

3. Since Northumberland Ferries Ltd. is reliant upon the federal government, through Transport Canada, for its operations, the inquiry officers believe that its operations should reflect the policy of the federal government. Transport Canada is a participating Department in the National Strategy for the Integration of Persons with Disabilities, whose purpose is to encourage industry to develop and use equipment that will advance accessibility of transportation.

The inquiry's interim report was circulated to interested parties, and comments were received and analyzed. The Agency has noted the findings in their Final Report, which will also be distributed to interested parties. That part of the report dealing with proposed regulations will be incorporated into the Agency's regulation development program.

3.4 INQUIRY INTO CANADIAN MOTOR COACH SERVICES

This inquiry, entitled "The Road to Accessibility," is examining the level and adequacy of accessible services currently available on extra-provincial motor coaches. The inquiry is also to determine if it is appropriate to set a national standard for services, and the financial implications of doing this. Public hearings are being conducted throughout the country and it is expected that a report will be presented to the Minister of Transport early in 1993.

3.5 INQUIRY INTO GROUND SERVICES AT AIRPORTS

In response to a request from the Canadian Paraplegic Association, the Agency is inquiring into whether the equipment and services offered by automobile rental agencies, taxis, limousines and airport shuttle buses operating at or from Canadian airports present undue obstacles to the mobility of people with disabilities. At the time of writing, it is expected that the inquiry will be completed in the summer of 1992.

3.6 INQUIRY INTO THE POLICIES OF CANADIAN AIR CARRIERS

This inquiry into the policies, standards and practices of all Canadian air carriers with respect to transporting people with disabilities was conducted in two parts. The first part dealt with operators of large aircraft (30 seats or more) and has been circulated to interested parties; the second dealt with the accessibility of smaller aircraft (fewer than 30 seats) and should be circulated to interested parties in late 1992.

4. A CANADA-UNITED STATES COMPARISON

Chapter 9 of Volume 1 describes the frustration and progress that has occurred in relation to access to transportation for people with disabilities. It specifically mentions the *Americans with Disabilities Act of 1990*, a major event in the United States. This section describes the U.S. legislation and compares it with the situation in Canada.

Canada has not been alone in becoming more aware of the needs of people with disabilities. As is noted in Volume 1, Chapter 9, there has been frustration in Canada at the lack of progress in addressing these needs, including increasing access to transportation services. On the other hand, there has been progress in all passenger modes and it would be inaccurate to underrate the importance of the improvements that have occurred. The bus mode appears to have improved most slowly and, therefore, it is especially positive that the National Transportation Agency embarked on a major inquiry into accessibility within this mode.

In Canada, progress toward increased accessibility has been uneven. This is also the case in other countries that the Royal Commission examined. The example of the United States has been of particular interest to Canadian organizations of and for persons with disabilities, because of the passage of the *Americans with Disabilities Act of 1990*, which applies to the rail and bus modes, and the *Code of Federal Regulations* pursuant to the *Air Carrier Access Act of 1986*, which applies to the air mode. Some Canadian organizations would

argue that this legislation places the United States well ahead of Canada in its treatment of people with disabilities. The provisions in the Code and the Act are very comprehensive. In addition, the Act provides for new regulations regarding standards to be met. The following provides a summary of some of the major provisions.

4.1 AIR MODE

The *Code of Federal Regulations* puts into practice the *Air Carrier Access Act of 1986*, which states that, when providing air transportation, no air carrier may discriminate against any otherwise qualified person because of a disability.

The Act and the Regulations specify in considerable detail how aircraft and their interiors must be configured to make seats and washrooms accessible; how airport facilities should be designed; when an air carrier is required to provide transportation to a person with a disability and to provide the services that make the trip feasible (such as oxygen); how aircraft boarding and seat selection are to be performed; when and how personal equipment such as wheelchairs and other aids are to be stowed; how information must be provided to travellers with disabilities; and what special services must be available to people with hearing impairments.

The key provisions on arrangements for attendants accompanying travellers with disabilities are as follows:

• A carrier may require that an attendant accompany a person with a disability in specific circumstances for the safety of the passenger (for example, if a mental disability or severe hearing and sight disabilities prevent the passenger from understanding the safety briefing).

• If the carrier determines that a passenger must travel with an attendant, but the passenger believes that he or she is capable of travelling independently, the carrier shall not charge for transporting the attendant.

- If the carrier determines that an attendant is necessary but an extra seat is not available on the flight on which the traveller has a confirmed reservation, then the traveller with the disability shall be eligible for denied-boarding compensation.

As described earlier in Section 2 of these Notes, the National Transportation Agency has proposed regulations regarding accessible transportation, which will become effective one year after the date of their publication in the *Canada Gazette, Part II*. At the time of writing, the publication in Part II had not occurred. One important consideration to organizations of, and for, persons with disabilities relates to fares for attendants. This issue has not been covered in the regulations the Agency has promulgated to date. The Royal Commission's recommendation concerning attendants is similar to the U.S. requirement already in place.

In the United States, if the physical limitations of an aircraft with less than 30 passenger seats preclude the use of existing models of lifts, boarding chairs or other feasible devices to enplane a person with a disability, air-carrier personnel are not required to carry that person onto the aircraft by hand. In Canada, the currently proposed amendments to the regulations do not pertain to aircraft with fewer than 30 seats. Consequently, there are no regulations available at present to compare with those in the United States. A specific National Transportation Agency decision, however, suggests a direction for the Canadian situation. For example, the Agency ordered Canadian Partner (Ontario Express Ltd.) to make its transportation system accessible to persons with disabilities. This case involved a Jetstream 31 aircraft, which has 19 seats. In response, Canadian Partner is exploring, with manufacturers, the development of a device that will allow access to aircraft in a dignified manner by passengers requiring assistance. However, until a suitable device is available, passengers requiring assistance in ascending and descending stairs on the Jetstream 31 will be manually lifted by Canadian Partner crew. Training in various lifting techniques will be provided to the personnel involved.

In Canada, as described earlier, the National Transportation Agency has proposed regulations for domestic air carriers using aircraft with 30 or more seats. At the present time, Air Canada and Canadian Airlines International each have various special services, not currently required by regulation, to assist travellers with disabilities. These special services are similar to some of the provisions found in the *Code of Federal Regulations* for U.S. air carriers and include:

- advance seat selection;

- a toll-free line available in Canada for those with a Telecommunications Device for the Deaf (TDD);

- reduced fares for attendants on flights within North America;[8]

- transportation of wheelchairs free of charge in the cargo compartment and the provision of special packing for wet-cell battery packs used on motorized chairs;

- for in-flight use, airline-provided wheelchairs on all airplanes except DC-9s and Boeing 747 combis (Air Canada) and Boeing 737s and DC-10s (Canadian Airlines International);

- on all Boeing 727s, 767s and 747s (Canadian Airlines International only for the latter), Airbus A310s and A320s, and DC-10s,[9] washrooms that are accessible to passengers in wheelchairs;

- on all aircraft, except Air Canada's Boeing 747 combis and some 727s, retractable arm rests on selected aisle seats to ease the transfer of travellers from wheelchairs to their seats;

- oxygen "Medipaks," for passengers with respiratory problems, available at an extra charge with advance notice (72 hours for Air Canada and 24 hours for Canadian Airlines International);

- provision for guide dogs accompanying passengers with a visual or hearing impairment in the passenger cabin, except on flights to the United Kingdom and New Zealand, due to animal quarantine regulations in those countries;

- a variety of specially prepared meals when advised 24 hours in advance;

- individual on-board safety briefings; and

- a special facility at Lester B. Pearson International Airport with full-time airline staff offering assistance to passengers needing boarding assistance (Air Canada at Terminal 2 and Canadian Airlines International at Terminal 3).

4.2 SURFACE MODES

The *Americans with Disabilities Act of 1990* provides the criteria to determine if discrimination under the Act has occurred in providing transportation services to people with disabilities. Separate criteria are set out for:

- public entities such as bus, rail, or any other conveyance (other than aircraft or intercity or commuter rail) that provide the general public with general or special service (including charter service) on a regular and continuing system;

- operators of commuter rail transportation and intercity rail transportation (the latter being Amtrak); and

- private entities offering travel or transportation services. (These services include transportation by bus, rail, or any other conveyance, other than by aircraft, that provides the general public with service, including charter, on a regular and continuing basis.)

For the most part, there are differences between new and existing equipment and facilities. Generally speaking, new equipment must be accessible to travellers with disabilities. Private entities, however, operating purchased or leased vehicles with a seating capacity of fewer than 16 passengers face more relaxed requirements. Existing equipment and facilities must be fully accessible by specified deadlines.

One controversial area relating to the application of the Act and Regulations concerns over-the-road buses.[10] To deal with these issues, the Office of Technology Assessment has undertaken a study to determine:

- the access needs of individuals with disabilities to over-the-road buses and over-the-road bus service; and

- through consideration of all forms of boarding options, the most cost-effective methods for providing access to over-the-road buses and over-the-road bus service to individuals with disabilities, particularly individuals who use wheelchairs.

The study, including any options for legislative action, is to be submitted to the President and Congress by July 1993.

In Canada, for the surface modes, the major event related to accessibility is the proposed National Transportation Agency regulations relating to the training of carrier personnel to assist travellers with disabilities. As mentioned earlier in these Notes to Chapter 9, the Agency is in the process of preparing regulations concerning the terms and conditions for transporting persons with disabilities using federally regulated modes other than air (which has already received some attention). Regulations covering the accessibility features of transportation equipment in all modes of transportation under federal jurisdiction are also being prepared, as are regulations to standardize the communication of information to persons with sensory or cognitive impairments.

ENDNOTES

1. *National Transportation Act, 1987*. R.S.C. 1985, c.28 (3rd Supp.).

2. *Canadian Charter of Rights and Freedoms*. R.S.C. 1985, Appendix II, No. 44.

3. *Canadian Human Rights Act*. R.S.C. 1985, c.H-6 (2nd Supplement).

4. National Transportation Agency of Canada, *Accessible Transportation Services for Persons with Disabilities*. A Staff Report to the National Transportation Act Review Commission, May 1992.

5. *Canada Coach Lines Accessible Intercity Bus Service Demonstration, Preliminary Results* prepared by Transport Canada, Policy and Coordination, Transportation Development Centre, October 1991. Information on the total ridership, potential market of persons with disabilities and allocation of costs between Transport Canada and Canada Coach Lines was obtained from Transport Canada officials.

6. Kenneth A. Mozersky, Anne M. Hampel and Paul Lacoste, *Interim Report of the Inquiry into Level of Accessibility of Ferry Services* (Ottawa: National Transportation Agency of Canada, January 17, 1992.)

7. Ibid., p. 12.

8. The attendant's fare is 50 percent of the applicable fare (whether full or discount) at the time.

9. The DC-10 washrooms could be considered "not fully" accessible since the door to the washroom cannot be closed. Entry to the washroom is facilitated by a bar and a privacy screen, and the latter conceals the Washington chair and doorway while the washroom is in use. Canadian Airlines International, however, is phasing out its DC-10 aircraft.

10. An "over-the-road" bus is defined in the United States as one that has an elevated passenger deck located over a baggage compartment.

NOTES TO CHAPTER 18:
CHANGES IN COSTS TO 2000 S-Q AND 2000 D CASES — METHODOLOGY AND ESTIMATES

Introduction

Chapter 18 of Volume 1 describes the changes in costs by mode to be expected during the decade from 1991 to 2000 under *Status Quo* (S-Q) and *Directions* (D) conditions. The chapter describes the changes forecast using four trips as illustrations:

- Saskatoon to Halifax
- Toronto to Montreal
- Winnipeg to Churchill
- Halifax to St. John's

Subsequently, the system-wide changes to be expected in each mode are summarized when the total estimated costs for 2000 S-Q and 2000 D are presented in Tables 18-5 and 18-6 of Volume 1.

These notes will reverse this order, describing first the system-wide changes to be expected in each mode, and then offering some details for each of the sample trips where these differ from the system-average changes.

In general, the percentages of change cited here for various factors that differ from 1991 to 2000 S-Q, or between 2000 S-Q and 2000 D, are used in developing our illustrative estimates. They do not always match percentage changes that can be calculated from the tables in Chapter 18. The percentage changes implicit in those tables may differ because rounded numbers and sums of rounded numbers were used in the tables.

1. Changes Expected from 1991 to 2000 S-Q

1.1 CHANGES IN TRAFFIC BY MODE

Simple assumptions are made that, in the absence of the policy changes recommended by the Royal Commission, intercity traffic by mode in passenger-kilometres would grow between 1991 and 2000 by:

- Car   30%
- Bus   no change
- Airplane (domestic)   30%
- Train   no change
- Ferry   30%

These are not intended to be accurate forecasts, but merely illustrative of the possibilities, in order to allow the implications of the Royal Commission's recommendations to be explored. Their realism can be judged in light of the following observations about recent changes in traffic by mode:

- On Ontario highways, traffic increased between 1980 and 1989 by 36% measured in vehicle-kilometres by all classes of vehicle (separate estimates for car traffic being unavailable).[1]

- Passenger-kilometres on intercity buses are not available, but between 1980 and 1989, total bus-kilometres on intercity unit toll services fell by 16%, while total passengers carried fell by 47%.[2] It is noted, however, that part of the decline is attributable to the reclassification of GO Transit bus services from intercity to urban transit.

- Passenger-kilometres on domestic unit-toll air carrier services increased by 13% between 1981 and 1990, and by 32% between 1983 and 1990.[3]

- Revenue passenger-kilometres on intercity train services declined 3% between 1980 and 1989, and then, on VIA Rail services (87% of the 1989 total), almost halved in 1990.[4]

- The number of passengers carried on intercity ferries increased between 1980 and 1988 by 39% (46% on west coast ferries and 10.5% on east coast ferries).[5]

1.2 CHANGES IN COSTS BY MODE BETWEEN 1991 AND 2000 S-Q

1.2.1 Car

The 2000 S-Q case differs from the 1991 case in allowing for some improvements in vehicle fuel consumption, emissions and safety. Fuel efficiency and CO_2 emissions are expected by Environment Canada and the National Energy Board to improve by about 13% per vehicle (fleet average) by the year 2000.[6] In the cost estimates, the fuel component of vehicle/carrier costs is therefore reduced by 13% in 2000 S-Q, and the CO_2 component of environmental damage costs is reduced by 13%.

The Canadian Council of Ministers of the Environment, through adoption of its Management Plan, intends that NO_x and VOCs emissions will fall by about 40%, including the effects of announced vehicle emission standards and a number of specific programs in the "ozone-sensitive areas."[7] The NO_x/VOCs component of environmental damage costs is therefore reduced by 40% in 2000 S-Q.

Safety is predicted to continue to improve in terms of fatality rates per vehicle and per passenger-kilometre; recent trends have been strongly downward, but the longer term reduction is somewhat slower. On the other hand, the frequency of less-severe accidents and their damage costs continue to increase. An expectation that the reduction in deaths will predominate in the cost equations is represented by a reduction of 10% in the cost per passenger-kilometre.

The fuel tax component of special taxes/fees is assumed to be unchanged per passenger-kilometre, despite the reduction in fuel

consumption noted earlier. It is expected in the status quo option that governments would adjust tax rates upward to offset reductions in tax revenue per passenger-kilometre (their practice over the last 15 years having been to increase tax rates more than needed to offset reductions in fuel consumption per vehicle-kilometre).

Together, these changes would reduce average car costs per passenger-kilometre by about 4% by the year 2000.

1.2.2 Bus

The illustrative figures for the bus mode, projected to 2000 but presuming no change from the present regime of provincially regulated regional monopolies, reflect an expectation that, without major policy change, there will be little improvement in costs in this mode. Only the cost of accidents is projected to fall by 10% per vehicle-kilometre and per passenger-kilometre compared with 1991 — reflecting a continuing trend toward safer travel by improving vehicle technology and improving infrastructure and control systems.

This portrayal of 2000 S-Q bus costs could prove optimistic if the current decline in the use of this mode continues; however, for the system total and for the sample routes selected, continued deterioration has not been assumed.

1.2.3 Airplane

The carrier component of air travel costs is expected to continue to fall through 2000 as the older aircraft of existing fleets are replaced by newer airplanes that are fuel efficient, require fewer people in the flight crews, and have lower maintenance costs. New aircraft will reduce the cost of most Canadian domestic air operations. Aging DC-9s, Boeing 727s and early models of the B-737 are being replaced by a new generation of aircraft. These are quieter, can be operated by a cockpit crew of two (instead of three), and are much more economical on fuel.[8]

In some instances, the newer aircraft can accommodate twice the passenger load at the same fuel consumption. For airplanes, such as the Airbus A320 (which is replacing the B-727-200), the same number of passengers are transported at a 40% fuel saving (approximately 150 people in the "all-economy" configuration). A reliable picture of the maintenance costs for the newer aircraft will have to wait until they have aged, but substantial savings are indicated. The following estimated savings were developed using published U.S. airlines' data.[9]

SAVINGS: A320 over B-727-200

Crew	10%
Fuel	40%
Maintenance	20%

For illustrative purposes, and based on the above, the air operations cost models were projected to 2000 by adjusting fuel and labour costs. The aggregate effect was cost reductions, for system-average vehicle/carrier costs in the sample routes, of 11.5% to 13.5%. For the system average, the projected 1991 to 2000 cost reduction is approximately 12%. With cleaner engines and this fuel saving, an emissions reduction of 15% was estimated.

Air traffic has, with intermittent corrections, grown steadily over the years. It is reasonable to assume that such growth would generally continue. Transport Canada staff (from their Passenger Origin-Destination Model) provided Royal Commission staff with forecasts of air traffic origin-destination from 1989 to the year 2000.

The model forecasts indicate a growth in domestic airline traffic of 37% from 1989 to 2000. This amounts to approximately 30% for 1991 to 2000.

Although the traffic increase that is forecast would affect the economics of flying, particularly between lower density city pairs, it is not expected to have any important impact on the system-average load factors (presumed to be 67.5% for jet and 56% for commuter

turboprop) used in the carrier cost presentation. On the other hand, the impact on the average unit cost for under-utilized airports would be considerable — presuming that traffic increases are not matched with even more investment.

Aviation infrastructure spending is expected to grow much less than traffic, indicating that costs per passenger-kilometre will fall. Costs at Toronto and Vancouver airports are the exceptions; it is assumed that expansion costs at these airports would preclude economies in per-passenger costs. Otherwise, marginal costs for Calgary, Edmonton, Winnipeg, Ottawa, Montreal and Halifax are assumed to be 50% of 1991 average levels, and at smaller airports, zero. Presuming a system-average growth in airport activity (domestic and international combined) of 42% from 1989 to 2000,[10] average airport costs per passenger-kilometre would fall by 17% at the six airports listed earlier, and by 30% at smaller airports.

Air navigation services costs per passenger-kilometre are projected to fall system-wide by an average of 25% by the year 2000. Total land costs remain unchanged, but are averaged over a 30% greater volume of passenger-kilometres. Average costs attributable to land, therefore, fall by about 23% per passenger-kilometre. Overall, infrastructure costs fall by about 22%.

Improvements in average fuel consumption (as mentioned earlier) will continue as older models of aircraft retire and are replaced by more efficient versions. An improvement of 15% between 1991 and 2000 is assumed, producing an equivalent reduction in CO_2 and air pollutant emissions damage. In addition, environmental costs are projected to fall as noise costs are presumed to halve, following more extensive adoption of "Stage III" aircraft.

Aircraft fuel tax per passenger-kilometre is projected to decline by 15%, in line with fuel consumption. For cars, where fuel taxes are the main source of government revenue, it is assumed that governments would adjust road fuel tax rates per litre upward to offset declining

consumption. For air, no change in fuel tax rates is assumed. Had the assumption been the same as that made for cars, the difference in total costs in the 2000 S-Q case would have been relatively minor.

Airplane accident costs per passenger-kilometre are presumed unchanged.

In sum, domestic air travel costs per passenger-kilometre are projected to fall by about 15% from 1991 to 2000.

1.2.4 Train

Improvements in VIA Rail's cost-recovery performance were generally projected, but assumed to be restricted to its higher potential services. For the sample routes considered, no changes in cost and revenue levels were assumed in cost levels prevailing for Winnipeg to Churchill, or the Montreal to Halifax segment of the hypothetical Saskatoon to Halifax rail journey. For the Saskatoon to Toronto link, a large improvement in average passenger revenue was projected — reflecting an increased emphasis on higher-quality and higher-priced, tourist-focussed transcontinental service. Also included are more-modest increases in per passenger infrastructure and train costs — allowance for the net effects of lower passenger-kilometres per car-kilometre, adjusted in the case of train costs for predicted operating economies.

Projected changes for the Toronto to Montreal sample route are more substantial — in keeping with VIA Rail's plans for a faster service using improved equipment, which will garner higher revenues. Per-passenger vehicle/carrier costs are projected to fall from $124 to $106, revenue to improve by $4 and infrastructure charges to increase (by $2) due to higher speeds.

No change is expected in environmental, accident or special tax/fee costs per passenger-kilometre. The projected reductions in vehicle/carrier costs are sufficient to reduce train costs per passenger-kilometre overall by about 4% between 1991 and 2000.

1.2.5 Ferry

No change is anticipated in the costs per passenger-kilometre of any of the ferry services. However, system-average vehicle/carrier costs would fall slightly as growth is expected to be more vigorous among the west coast services (40% growth in passenger-kilometres, compared with 10% on east coast services), and those west coast services have much lower costs per passenger-kilometre.

Overall, ferry costs per passenger-kilometre are projected to fall by about 3% between 1991 and 2000.

2. CHANGES EXPECTED FROM 2000 S-Q TO 2000 D

2.1 CAR

The year 2000 D case essentially involves:

- A large shift in the burden of the infrastructure costs from taxpayers to users;

- Introduction of payments by users for the environmental damage costs to users, offsetting costs borne by others; and

- A transfer to users of that portion of accident costs hitherto borne by others.

Accident cost changes are a simple transfer. We do not assume any further improvement, although the change in responsibility for cost might well be an incentive for improvement. The infrastructure cost changes and environmental cost changes are more complex, and will be described further.

The analysis of 1991 system-average costs suggested that, within car infrastructure costs, the costs of "control" were matched by registration fees, but the remaining costs of the "way" (including capital charges and land costs, as well as pavement wear and maintenance

costs) were approximately double the revenues received by governments from special fuel taxes. Infrastructure cost recovery could be achieved by doubling the fuel tax rate. Implementing the Royal Commission's recommendations, however, should lead to the application of more rigorous criteria to expenditure decisions on the road network, slowing expansion relative to traffic growth.

To illustrate the possible consequences, infrastructure costs are assumed to be about 5% lower in the 2000 D case. Presuming that the fuel tax (the dominant element of the 2000 S-Q special transportation tax/fee) was the means of collecting the infrastructure charge, it would only need to be increased by about 90% to cover the comprehensive costs throughout the road network.

It is expected that, at least for the next decade or so, road infrastructure charges would be applied (through fuel taxes) at the same rate network-wide, rather than differing by link. The new average charges would therefore produce large surpluses over costs on the links with dense traffic, particularly expressway-standard highways. The surpluses would be needed to cross subsidize less-travelled routes that continued to under-recover. This is evident in the illustrations for sample routes, all of which (except Winnipeg to Churchill, which has no continuous road link) are on major highway routes, with sufficient road traffic to show surpluses on the new infrastructure charges in the 2000 D case.

The net cost increase to users under the 2000 D scenario from infrastructure, environmental and accident charges, less special taxes, would not add dramatically to fully allocated average costs per trip. As of 2000, it would constitute an 8% increment to the average cost per passenger-kilometre, or per trip. The increment would be, however, a larger portion of the "out-of-pocket" costs perceived by motorists, and would amount to a large percentage increase in the effective cost of fuel consumption. This might be expected to cause appreciable changes of travel behaviour and especially in the type of vehicle purchased. In the 2000 D illustrations, it is assumed that

these reactions will produce another 10% reduction in both fuel consumption and emissions.

Overall, car costs per passenger-kilometre fall by about 2%. It should be noted, however, that demand for road travel will also be some-what dampened through travelling less and switching modes, which is not represented in the tables.

2.2 BUS

Regulatory reform, to allow entry to the intercity scheduled bus industry on the basis of "fit, willing and able" criteria, would open the bus industry to competition, and give operators greater commercial freedom. This could induce cost efficiencies and the removal by carriers of internal cross subsidies among routes. Potential efficiencies are illustrated by a 15% reduction in vehicle-carrier costs of the bus services once carriers are free to adjust equipment, schedules and fares to the market, and to withdraw from services where patronage is insufficient.

The analysis of 1991 costs suggested that public infrastructure costs — the allocated costs of the road system, including capital charges and land costs—are almost balanced by the "special taxes/fees" from buses. Infrastructure costs per bus-kilometre would fall very slightly (about 5%) along with the overall improvement in road infrastructure spending described in the section earlier on car costs. The new infrastructure charges per bus-kilometre would be introduced at levels only slightly higher than those taxes and fees that they replaced. Adjusting for the improvement in average load factor, infrastructure charges per passenger-kilometre would fall further.

User charges would also be instituted for environmental damage costs, transferring the costs from the general public to bus users. These environmental charges would induce bus fuel consumption improvements and emissions reductions, reinforcing reductions arising through more stringent regulations. The scope for additional

improvement in bus emissions per vehicle-kilometre appears large relative to that for cars. Compounding this, with a load factor improvement projected for the 2000 D scenario, a reduction of 30% would be a reasonable expectation.

Overall, operating efficiencies and the removal of cross subsidies would mean that costs borne by users would fall by about 11%, even after imposition of the new user-charges. The average full cost of a passenger-kilometre of bus travel would fall by about 15% from the 2000 S-Q scenario.

Bus costs used for the route-specific illustrations are not estimates of actual costs for the routes in question. They are based on adjusting the system-average costs developed (see Notes to Chapter 3 in this volume) for factors specific to the route type. In some cases what they portray may not be accurate. For example, the costs illustrated in the 1991 and 2000 S-Q cases for Halifax to St. John's are not actual costs of the service provided by CN Roadcruiser, but generic costs for similar services provided privately elsewhere. The actual costs are probably substantially higher. For the Newfoundland service, the expectation is that privatization and/or contracting for operation of subsidized services might well reduce costs proportionally more than shown in Table 18-4, which is based on expected changes in system-average costs.

2.3 AIRPLANE

No further changes in air carrier unit costs, except for infrastructure and environmental charges, have been assumed to result from the 2000 D scenario.

Applying the disciplines of full cost recovery and user-sensitive management to airport and air traffic control investment and management should result in infrastructure cost reductions. Actual economies from eliminating excess costs would vary widely by site. Cost saving potential in airports is represented by a reduction of 10% in costs per

passenger at Toronto and Vancouver airports, 25% at medium-sized airports, and 35% at smaller airports. Special circumstances are illustrated for the Winnipeg to Churchill example, discussed later.

The illustrative cost reduction presumed to be achieved from public utility style management of air navigation services is 25%. Improvement might well exceed that, as illustrated by the success of the Airways Corporation of New Zealand.[11] Infrastructure costs therefore fall by about 18% on average. Carriers and passengers would be charged directly for these infrastructure costs, but with the exception that the smaller airports[12] would retain transitional subsidies, estimated at $40 million in total in 2000.

The federal fuel excise tax would be eliminated, replaced by a charge for environmental damage. This would induce some additional reduction in aircraft emissions through improved technology or operating practices, illustrated as a reduction of 5% in environmental costs per passenger-kilometre.

Overall, air travel costs per passenger-kilometre fall by about 5% compared with 2000 S-Q. User costs per passenger-kilometre increase by about 10%.

2.4 TRAIN

Different effects of the 2000 D scenario on rail carrier and infrastructure cost, and consequent changes in service offerings, are illustrated for the Toronto to Montreal and Saskatoon to Halifax examples, and in subsection 2.6 for the Winnipeg to Churchill example.

The 2000 D scenario illustrates a possible niche for rail on the Toronto to Montreal route. One hypothetical niche could, of course, be a Toronto to Montreal high-speed rail system; however, even if a decision to proceed were taken on the completion of present studies, the system would not be operative until well after 2000. The niche for rail assumed under the 2000 S-Q scenario involves a system that is more

expensive to the user — much more expensive. In part, this would be due directly to full commercial cost recovery. Also, with its prices rising, the only possible approach would seem to be for rail travel to seek a market by moving "up scale."

Part of the projected price rise to an average Toronto to Montreal fare of $119 by 2000 (still supplemented by a transition subsidy of $21) is attributable to improved speed, comfort and service. It is possible that travellers would be unwilling to pay 22 cents per kilometre (24 cents per kilometre standardized to air distance, rising to 28 cents over about three years as the VIA Rail subsidy completely disappeared in 2003), even for an improved rail service, and the mode would fail to survive in an open market. Such a rail operation would, however, provide a markedly improved service, and fill a niche closer to air travel than to bus travel. It would cost less than 75% (rising to 87% as transitional subsidies are phased out) of the price of air travel, be more comfortable, and require only marginally more — or in some cases less — travel time, depending on exact origins and destinations within the metropolitan regions. The time disadvantage of rail is further diminished if time spent less conveniently (that is, time in taxis or terminals) is weighted more heavily relative to time spent comfortably aboard the train or airplane.

Saskatoon to Halifax by rail would cost the user more than four times the air price, or $1,556 for a trip with three changes of trains and with average accommodation, when the transition process is complete early in the next century. (Declining subsidies would mean that the trip would cost $1,271, or more than three times the price of air, in 2000.) Anyone choosing such a trip at this cost would doubtless want better-than-average accommodation, and would have to pay substantially more. The system-total reduction of rail passenger-kilometres for the 2000 D scenario by half (to 0.7 billion passenger-kilometres) recognizes the likely major effect of increasing costs on rail patronage. Remaining rail service would probably be concentrated on higher-volume routes and some tourist services.

Because the potential for fuel consumption and emissions reductions appears large, especially as part of a process of concentrating services on higher-volume routes, it is illustrated by a 20% reduction in environmental damage costs per passenger-kilometre.

2.5 FERRY

Major changes would be introduced to ferry financing, through a phase-down of subsidies over a 10-year period. In the illustrative case it is assumed that, by 2000, this would apply even to the ferry services that are "constitutional" obligations, and that the subsidy would, by 2000, be only about one quarter of its 1991 level. This stimulus, together with the introduction of other management incentives to efficiency (including the ability to contract services in publicly owned ships, and the institution of an advisory panel of users on services and fares), would be expected to reduce costs. In the illustration, it is assumed that costs fall by 20% per passenger-kilometre on the east coast services and by 5% on west coast services (for which average costs per passenger-kilometre are already substantially lower).

Introducing direct charges for environmental damage would prompt reductions in fuel consumption and emissions of about 20%.

There is also scope for reduction in the average costs of the publicly provided infrastructure. Full cost recovery by Transport Canada, together with the creation of a users' advisory body on investments, services and charges, should stimulate efficiencies in provision of the services. This is represented in the illustration by a reduction of 10% in the infrastructure cost per passenger-kilometre.

In summary, costs to users per passenger-kilometre rise by about 40%, while overall comprehensive costs per passenger-kilometre fall by about 9%.

2.6 CHURCHILL TO WINNIPEG: AN ILLUSTRATION OF CHANGE

The town of Churchill has approximately 1,200 residents and no road access. Expenditures by "taxpayers" to maintain existing passenger transportation to and from Churchill are very large per trip, and relative to the total population of the area served. A $19.5-million passenger-rail subsidy in 1990 equalled over $16,000 per resident of Churchill; the airport subsidy amounted to another $8,000 — slightly less if the population served using Churchill Airport as an intermediate point is considered. These are large amounts relative to benefits to the residents. Under the 2000 D scenario, air and rail connections would still be provided but at much lower cost to taxpayers.

2.6.1 Air

Churchill Airport accounts for a total annual cost attributable to commercial aviation of $9,524,000. Of this, $3,951,000 and $1,368,000 would be required to cover airfield and terminal capital investments respectively. Operating costs, excluding depreciation but including Transport Canada overhead, were $4,234,000 in 1990-91. Thompson, Manitoba, however, has a lower comparable total annual cost (including cost of capital) and lower operating costs, of $2,832,000 and $977,000 respectively — and Thompson handles similar aircraft and three times the passenger traffic of Churchill. Other comparisons with airports handling similar commercial traffic also confirmed that Churchill is over-built for the commercial aviation traffic it handles.

Although some of the airport facilities might be justified on the basis of military use or other benefits, it would seem reasonable to run an airport at Churchill for about 100 to 150 passengers daily at an operating and maintenance cost of the order of $800,000 annually, or $23 per passenger. Under the 2000 D scenario this would occur.

Presuming that the over-building were written off, it remained to estimate necessary sustaining capital. Here, as will be the case with any specific site, the question of the necessity of providing a full-service jet facility arose; a facility for turboprop aircraft was presumed

adequate, at an estimated (sustaining) capital charge of $500,000 annually. Thus, including the charge for using Winnipeg, a total airport cost per passenger of $37 would seem reasonable. To this is added $6 for air navigation services, for a total infrastructure cost of $43. The total is still a substantial increase over the $25 that the average passenger would pay under the 2000 S-Q scenario. For illustrative purposes, a transitional subsidy of $9 is shown, with the average passenger paying $34.

2.6.2 Rail

Table 18-3 in Volume 1 illustrates, for Churchill to Winnipeg travel, an important aspect of the Royal Commission's recommendations for rail in more remote circumstances — Recommendation 12.5b, that "any subsidized remote access service (regardless of mode) be designed to take passengers out to and bring them in from the closest convenient point where transfer can be made to a commercial unsubsidized carrier." Rail travel (the average of fares for upper and lower berths) from Winnipeg to Churchill presently costs the traveller $229, and would continue to do so under the 2000 S-Q scenario. This is insufficient even to cover the allocated $280 cost for the use of CN's track. Most of the total cost (including a $41 credit for the excess of attributable fuel taxes over the normal sales tax[13]) of $2,978 per passenger is paid by the taxpayer. No improvement in this cost recovery is predicted unless there is a major change in the service offered.

2.6.3 Intermodal

There is bus service to Gillam, 265 km to the south of Churchill. The illustrative table for 2000 D shows a bus-train service that would provide transportation to Churchill at a total cost of $179. A mixed passenger and freight train with basic coach and baggage service was assumed to be used.[14] This would lack the comforts of the present sleeper service with meal and beverage amenities, but the distance and time involved would be much less. Analogous to the situation for the air mode earlier, a transition subsidy is illustrated — in this case $40.

ENDNOTES

1. Ontario Ministry of Transportation, *Provincial Highways Traffic Volumes 1989* (Toronto: Ministry of Transportation, July 1991).

2. Statistics Canada, *Passenger Bus and Urban Transit Statistics*, Catalogue No. 53-215, Annual.

3. Statistics Canada, *Air Carrier Operations in Canada*, Catalogue No. 51-002, October–December issues, 1981–1987, and *Canadian Civil Aviation*, Catalogue No. 51-206, 1988–1990 issues.

4. Statistics Canada, *Railway Transport: Part IV, Operating and Traffic Statistics*, Catalogue No. 52-210, 1980 and 1981 issues; unpublished data provided in personal communication by Statistics Canada for 1982–1989; VIA Rail traffic in 1990 from VIA Rail Canada, *Annual Report*.

5. Unpublished data provided in personal communication by Statistics Canada, together with data from Société des Traversiers du Québec, *Annual Reports*, 1980–1988.

6. National Energy Board, *Canadian Energy Supply and Demand 1990–2010*, Catalogue No. NE 23-15/1991 (Ottawa: Supply and Services Canada, June 1991). Table 4-12 shows total car stock and truck stock fuel efficiencies improving between 1989 and 2000 by 1.5 percent per annum and 1.4 percent per annum respectively; 1.4 percent per annum for 9 years 1991–2000 would be an improvement of about 13 percent.

7. CCME, *Management Plan for Nitrogen Oxides and Volatile Organic Compounds, Phase I*, CCME, Nov. 1990. The National Energy Board in *Canadian Energy Supply and Demand, 1990–2010*, Tables 11-2 and 11-3, expects NO_x emissions between 1990 and 2000 to fall by about 50% in cars, 38% among gasoline-fuelled light trucks and 20% among diesel-fuelled light trucks, and VOCs emissions over the same period to fall by 40% to 45% among cars and gasoline-fuelled light trucks, and 30% among diesel-fuelled light trucks.

8. State-of-the-art new aircraft are also expensive; however, this does not have as large a bearing on total cost as does the operating cost side. The financial costs — depreciation and cost of capital — associated with even a relatively young fleet would rarely exceed 10 percent of an airline's total costs.

9. *Air Transport World*, several issues — 1989 to 1991.

10. Growth of 30 percent is assumed for 1991 to 2000.

11. See: "ATC turns a profit" and "New ATC Network Comes in on Target," *Jane's Airport Review*, March 1992, p. 10 and pp. 26–29.

12. The smaller airports are those designated as level 4 and 5 in the airport cost analysis: see "Notes to Chapter 3" in this volume.

13. The Manitoba and Saskatchewan early-1991 provincial fuel taxes of 13.6 cents and 15 cents per litre of fuel used for rail travel within these provinces were used. This substantially exceeds their 9 cent and 10 cent per litre taxes on automobile gasoline. (It is noted that Manitoba raised its tax on gasoline to 10.5 cents per litre in May 1991.)

14. Neglecting the Crown corporation status of the logical operator — CN Rail — some financial support or alternative persuasion might be necessary if the carrier were to be convinced to initiate such a service (where potential profits are small and financial risk substantial).